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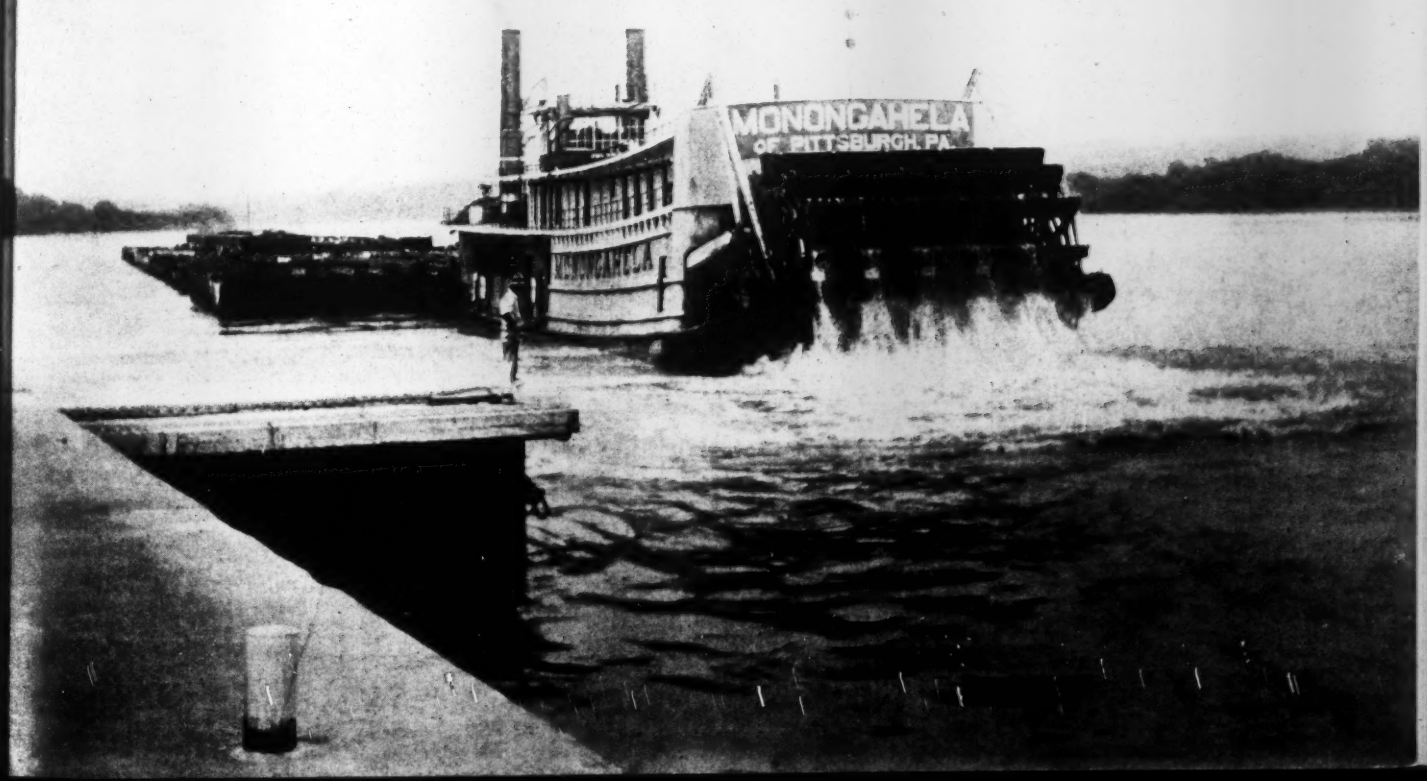
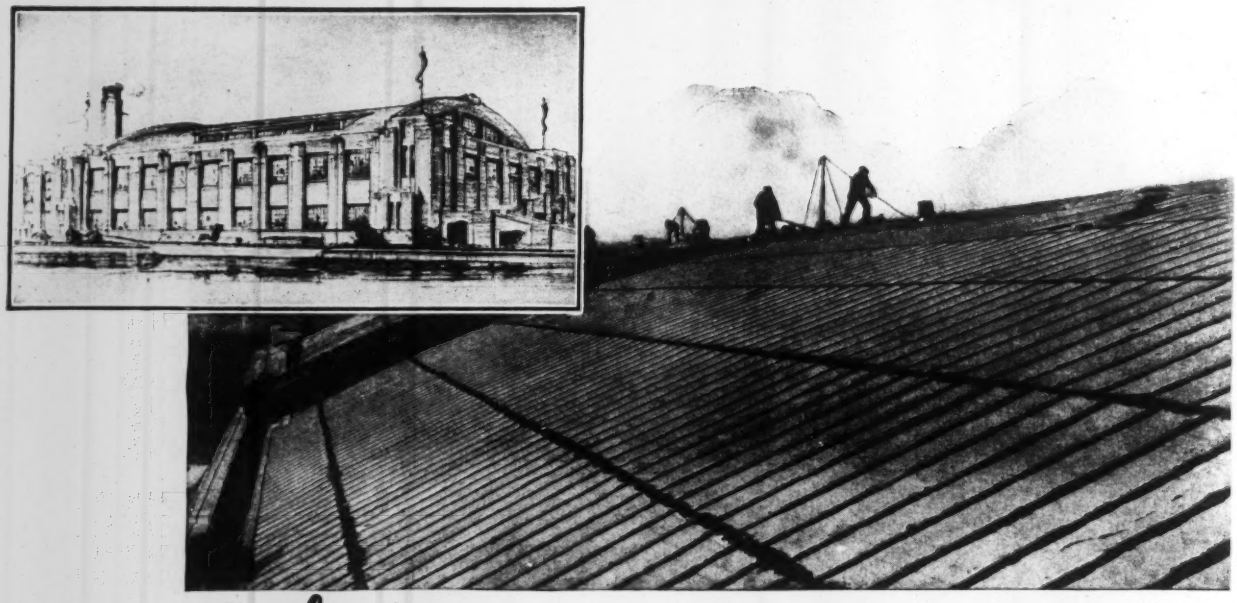
Ohio River Canalization

Its History and Possibilities

Col. C. W. Kutz discusses the engineering and economic problems of the greatest river canalization project ever undertaken in this country. His close contact with the work while in the Corps of Engineers enables him to speak with authority



Chicago's Lake Front Development



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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, MARCH 13, 1930 Number 11

The Hazard of Great Floods

TO ANY who may doubt the necessity of looking far ahead in matters of flood protection, the last fortnight's flood disaster in the south of France gives occasion for further reflection. The regions which experienced the great visitation have many centuries of knowledge of what storm and flood might bring, yet the recent great rains which fed their streams overcame all the protection with which they had surrounded themselves. Even in the absence of definite figures on the amount of the rainfall it is clear that prevision based on the flood chances indicated by long records did not suffice; thus it is once more shown that a large margin is in order when efficient flood protection is to be provided. Recent years have repeatedly demonstrated that, especially with short weather records, such as we have in our own country, rare combinations of conditions may bring a very great flood, far beyond anything forecast through moderate extension of high-water records. They have also shown that it is hard to bring this risk home to the citizen and cause him to provide against a long-distant chance of extreme flood. This is probably true also in the old countries of Europe, for one generation will not look far back of its own memory, or spend much money to provide the extra protection which may not be needed until the time of its grandchildren. These conditions invite thought in connection with the extensive flood-protection construction which the next few decades are likely to bring. Is it enough to build for a 25- or 50-year contingency? We believe that any comprehensive appraisal of the cost of great flood disasters—at least if the reckoning includes more than mere money—will show that nothing less is adequate than to provide for all-time possibilities, so far as these can be gaged.

Rolled Light-Alloy Shapes

WITH the commercial advent of large sections of light-alloy shapes, numerous structural possibilities that hitherto were little more than academic become concrete. Weight savings of decided magnitude can be realized through use of these shapes—at a price, it is true, but price is often less important than the power to accomplish a new result. Tests reported several weeks ago give tangible demonstration of the strength attainable in light-alloy structural assemblage, and furnish some of the main data needed for design. The tests do not provide all that is required for service, since the factor of experience plays an overwhelming part in structural engineering. Accordingly, practical application of the new material will probably go forward slowly; time and many bold trials will be required before the proper fields of use for light-alloy structural work are clearly determined. But regardless of this limitation it is a most significant development that an added resource has been placed at the engineer's command, with a notable range of performance in respect to both weight and corrosion resistance. It is certain that new achievements in meeting the manifold demands of practical construction will flow from this addition to engineering resources. Present limits of feasibility may be pushed forward in more than one direction.

Care in Placing Concrete

PROGRESS in the art of proportioning materials for concrete mixes, which naturally has focused attention on the advantages to be gained by careful mixture design and control, must not be allowed to lessen vigilance in getting proper placement in the forms. With the higher strengths obtained by better proportioning, higher working stresses are being used and it is even more important than before that placement be supervised with care. In the recent Woodway Park viaduct at Seattle (Feb. 20, 1930, p. 327) the strength of the material was assumed at 3,000 lb. and the flat slabs of 40-ft. span were designed accordingly. It was necessary to use high stresses and long spans in order to build this structure within the limit of funds available. Care was given to the proportioning, but care did not end there. Simple formwork and ample spacing of steel within the forms made it possible to pour concrete directly into place—such factors as these were recognized as essential to the notably good concrete job which was responsible for the success of the long slabs. Because aggregate gradation or minimum permissible strength can be specified in precise terms, the mistake may easily be made of overemphasizing the mixture proportions and forgetting that attention and care are necessary in order to get the best possible placement in the forms. Only when concrete is so carefully placed as to give complete assurance of obtaining the prescribed strength in the structure as a whole is it safe to use high working stresses and realize the resultant savings.

Winter Paving Accomplishment

MASTERY over cold in highway construction finds perhaps its greatest obstacle in laying asphalt pavement. The normally thin layer in which the material is put down has a large surface exposed to frost but only a small mass to retain heat; moreover, spreading and raking are effective heat-dissipating procedures. Yet it is necessary that the subsequent rolling be done while the material is hot and before surface chilling introduces the hazard of a crust which checks and bridges under the roller. And, finally, the rolling process requires a reasonable area of operation. To meet these conditions the paver who works with asphalt in cold weather must de-

liver hot material and must deliver it continuously and in quantity. Then spreading and raking must keep pace with delivery, so that the rollers have ample area for operation before any fraction of it is chilled below the temperature required for perfect compression. These are precisely the procedures followed in cold-weather asphalt paving operation along the Chicago lakefront. A notable concentration of equipment and men placed 8,388 sq.yd. of pavement, or 900 tons of asphalt, each day for eight days; this is not far from four times the work done in the normal asphalt plant operation. In effect the work was so rapid that it outspeeded the action of the winds and frost. It demonstrated that asphalt paving is practicable at any temperatures that ordinarily prevail in winter; indeed in this instance at temperatures at which it was deemed inexpedient to place concrete base. Obviously the economics are more uncertain. In the Chicago operation and in other exceptional conditions of traffic demand and street closure, any reasonable extra cost of winter construction is a paying investment. In a larger number of instances it would be found not profitable, especially as wise planning and scheduling of street improvements can usually make it unnecessary. As in all sound engineering of winter construction, the earning ability of earlier operation has to be balanced against the greater investment in construction.

Notable County Road Practice

ONLY rarely can a metropolitan county start virtually from scratch in improving an old highway system to modern traffic standards. Jackson County, in which Kansas City is located, was able to do just this. Two years ago it had no country roads improved beyond the stage of waterbound macadam, and these were old and worn. Except for eight trunkline state-road radials into the city from the east and south, no established improvements restricted the selection of old roads to be co-ordinated into a county system of primary and secondary thoroughfares. This opportunity for free action was utilized to develop a well-distributed system of main roads which divided the county into local road areas of notably uniform size and bounded on all sides by primary roads. In part this uniformity of main road distribution comes from the section-line highway location common to the western Mississippi Valley states, but the more important factor was engineering control of route selection. The steps in the engineering direction deserve attention. A technical study of conditions and requirements was translated into a definite plan and estimate. These were presented to the people for acceptance, financing and prosecution. Their response with an appropriation of six and a half million dollars was not on a general understanding that their highways were to be improved but on a definite commitment to a prescribed system of roads of defined character. In effect the proposed investment in highways by Jackson County was presented in the engineering terms employed in recommending an investment in plant and structures to a business corporation. The novelty of Jackson County road improvement is not that engineers are designing and constructing the roads being built, but that they organized and directed highway thinking and action in specific terms. Many communities can study this lesson with profit. As requirements for highway expenditures multiply, the demand will be more persistently for precise definition by highway officials of purposes and results, as a preliminary to supply of funds.

Watch Underground Water Supplies

OF UNUSUAL interest to the sanitary engineer is a study of the outbreak of dysentery and typhoid that recently occurred among the users of the deep-well water supply of Fond du Lac, Wis. The water-bearing strata tapped by the wells were contaminated by chance interconnection with a grossly polluted river through the agency of an abandoned well. It is not surprising that such an unusual set of conditions was not foreseen and guarded against by the Fond du Lac authorities, but now that an epidemic has been caused it behooves water-works officials and sanitary engineers generally to give careful thought to the possibilities revealed by this occurrence added to other calamitous experiences with polluted well-water supplies.

In general, it can be observed that it is not sufficient merely to select a source of supply usually yielding water of a high degree of purity. Those responsible for a water supply must still exercise that eternal vigilance which the health of a community deserves. In this instance deep wells, which ordinarily may be expected to produce water that is dependably pure, were no exception to the principle. The very excellence to be expected from the well output proved to be a source of weakness in encouraging a laxity in safeguarding the citizens against an unusual set of conditions.

More specifically, the case calls to the attention of the engineer the fact that in punching holes into the earth's crust to a depth of a thousand feet he does not necessarily eliminate danger, but may merely put it out of sight. It is perfectly obvious, now, that tapping an underground source is also tapping a source whose tributaries do not lend themselves to accurate survey and examination, and this very fact should be sufficient reason for the constant supervision or continuous safeguarding of underground as well as surface water supplies.

A Tunnel Project

A SITUATION of exceptional interest presents itself in the discussion of a second Hudson River highway tunnel now current in New York and New Jersey. The project is instructive evidence of the growing proportions of the planning and construction called for by present-day needs.

Only ten years ago the Holland tunnel seemed a dubious enterprise, even at a cost hardly one-third that of the new tunnel. But the Holland tunnel has made a phenomenal success, technically as well as financially; it has proved itself to be well planned and built, efficient in traffic service, and so remunerative that in spite of its unexpectedly high cost it will be paid for within another eight years. This fact, with the ever more clearly recognized need for better integration of the New York region, supplies a solid foundation for the new project. Moreover, the forecasts and estimates, based on thorough knowledge and highly dependable, establish the commercial justification of the project even without considering collateral benefits; the new tunnel can be paid for almost as rapidly as the present one.

Technically it involves no new difficulties. Considered as an avenue of traffic, it presents unusual problems in the disposition of traffic at the city terminus and in the possibility of joining separate traffic streams. The latter particularly is a matter for serious concern as respects safety, for the joining of traffic streams in tunnel, espe-

cially on down grades, appear to involve large hazards; one of the two projects presented to the state authorities last week avoids these hazards by placing all connections in open air, an eminently satisfactory solution of the difficulty. These traffic features of the tunnel project itself and of its connection with the city tunnel already authorized make it a subject worth careful study by engineers everywhere.

Quite separate from the engineering features, however, grave questions of public policy surround the whole enterprise. Not only is the rivalry of the tunnel commissions and the Port Authority a surprising example of competitive relationships among public bodies, but the case involves two other questions. One of these, the danger that the Port Authority may be turned away from port development to other functions, was referred to in these columns only a month ago (see "Real Port Development," Feb. 13, p. 269). The other, no less important, is the question of whether, and to what extent, public toll facilities may safely be pooled for mutual support and whether the perpetuation of tolls is sound policy. Now that the practicability of the tunnel is established, this question is the most critical element of the situation; it deserves fullest consideration.

Jersey Water Problems

WATER supply for the densely populated portions of New Jersey, and particularly for the northeastern portion of the state, has been an urgent question for half a century. Since the report of a state water commission 50 years ago recommending state construction the problem has been allowed to drift with partial attempts to solve it by private companies, acting for themselves or for individual municipalities, and later with the construction of the district works for Newark and other municipalities now about ready for use. Because of constitutional bars, which the people have been too apathetic to remove, state financing has been prevented. The district system has proved cumbersome.

A fundamental change from these conditions is offered in an able plan of statewide application which, together with more detailed proposals for a Northern Metropolitan District, has just been unfolded by the State Water Policy Commission, a body created last year. Commendable basic proposals are: that water-supply districts or regions be created, for the present three in number; that each locality, while retaining its distribution system, should merge its source of supply in that of the whole district whenever its supply becomes inadequate to its needs; that all common sources of general supply be interconnected; and that the state provide a revolving fund of $7,000,000 for the immediate purchase of reservoir sites and water rights, the state to be repaid by the districts when the water is actually put into use. For the proposed metropolitan district a much larger region and supply at a higher elevation are outlined.

Except for the revolving fund and its use, consummation of these recommendations awaits legislative action, especially authorization of a means of administrative control. The most promising plan of such control yet proposed is one permitting the formation of regional governmental areas for the provision and maintenance of various urban engineering services, including water-works.

Early legislative action on the commission's recommendations is demanded because its report indicates that by 1940 the northern district will need more water than can be supplied, while in the meantime there will be danger of local shortages unless the interconnections mentioned have been made. The other regional needs of northern New Jersey are almost equally imperative—some perhaps more so. They include sewage disposal, flood control, meadow reclamation and transit.

Navigation on the Ohio

THE greatest river canalization project ever undertaken in this if not in any country was completed last fall. As a result, the Ohio River is now open to navigation by vessels of 9-ft. draft for its entire length from Pittsburgh to Cairo, approximately 1,000 miles.

Completion of the project has been looked forward to alike by friends and foes of inland waterways, because here, if ever, would be found conclusive evidence of the possibilities of waterways in inland transportation. Freight has always moved on the Ohio River since the valley was first settled by white men; in large quantities before the advent of railways and then gradually falling away to negligible quantities except in certain regions. In these latter regions—chiefly at Pittsburgh, where the Allegheny and Monongahela join to form the Ohio—vast quantities of bulk commodities move on the transportation system made by the three rivers branching out through that great industrial center.

Much of the Pittsburgh traffic is local, the rivers being to this extent an interplant system upon which private corporations move their own materials in privately owned vessels. Hence the cost of handling freight in the Pittsburgh region cannot be taken as a measure of the saving which may be expected from the whole system. But some of the traffic does move down the river—structural steel is loaded on barges for delivery to shipside at New Orleans—and more will move now that the Ohio is open to navigation throughout the year. The cost of moving this freight as compared with rail cost can give a fair basis for attempting to determine the saving in transportation costs which may come from opening of the Ohio River system.

Estimates of the savings vary widely, ranging from that of the railroad operator to that of the waterway advocate. Colonel Kutz' estimates (on another page) are those of the Corps of Engineers, figures which recently have been brought into question as being unreasonably favorable to the waterway (*Railway Age*, Feb. 1, 1930). Colonel Kutz believes that even including the cost to the public in interest on the investment and maintenance charges a substantial saving can be shown, while *Railway Age* estimates that when the cost to the public is including the total cost per ton-mile exceeds the corresponding rail cost.

Considering both points of view it is safe to assume that definite savings can be shown on at least part of the river traffic. But it is possible that the saving may be so small that, were the waterway to take away enough traffic from competing railways as to affect their income seriously, the general public would suffer for the benefit of a few large shippers and receivers. Only with a great increase in the amount of traffic to be handled from the Pittsburgh district down the Ohio and Mississippi can it be safely said that the public at large will be benefited by its investment in this great canalization enterprise. Future plans for waterway development, therefore, depend vitally on the growth of Ohio River transportation within the next few years.

Ohio River Canalization —Its History and Possibilities

Fixed and Movable Dams Make the River Navigable Throughout Its Entire Length for Vessels of 9-Ft. Draft—Prospects for Future Increase in Traffic Are Bright

By C. W. Kutz
Colonel, Corps of Engineers, U. S. A., Retired, Washington, D. C.

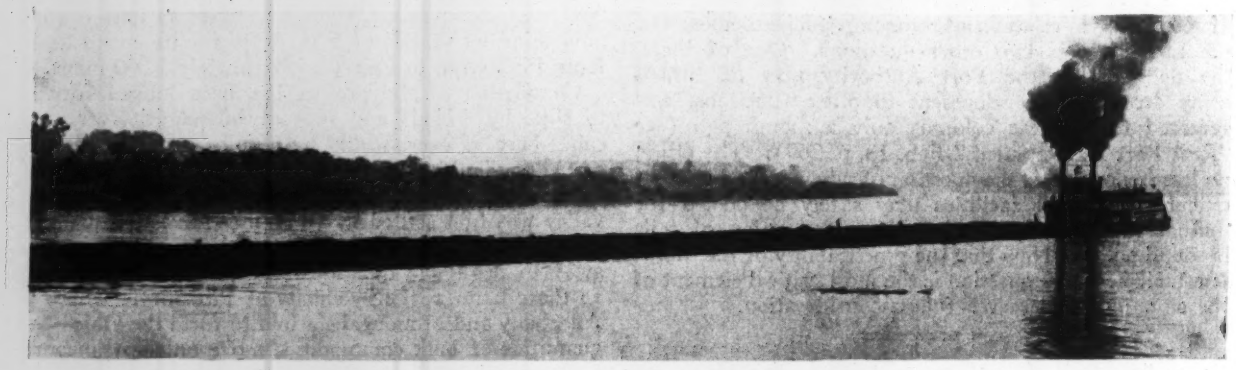


FIG. 1—10,000-TON COAL CARGO, TEN BARGES

FORMED at Pittsburgh, Pa., by the junction of the Allegheny and Monongahela, the Ohio River extends for 980 miles to Cairo, Ill., where it empties into the Mississippi River. It is a state boundary stream, separating West Virginia and Kentucky on the east and south from Ohio, Indiana and Illinois.

From colonial days until the building of railroads it was a very important highway of commerce and all the early cities of that region were located on its banks. Its usefulness, was, however, seasonal in character, as in its original condition it was obstructed at low stages by numerous bars with depths over them of 1 to 2 ft. and by the falls at Louisville with a low water drop of 26 ft. in a distance of 2 miles.

A hundred years ago a toll canal was built around the falls by a stock company chartered by the State of Kentucky. Elsewhere on the river work was done by the federal government, but until 1879 the federal work was limited to the removal of snags and the construction of contracting dikes at critical points. In that year Congress authorized the construction of a lock and dam 5 miles below Pittsburgh, known as the Davis Island dam. At that time river interests were unalterably opposed to the building of a fixed dam with lock, believing that the time lost in maneuvering through the lock would more than offset the advantage of dependable depths in the pool above the dam. Some were opposed to any dam but finally acquiesced in the construction of a movable dam, one of the advantages of which lies in the fact that when the natural stage of the river provides the necessary depth the main part of the structure can be lowered to the bed of the river, thus permitting at such times the free and uninterrupted movement of navigation.

After examining a number of types of movable dams in Europe, Col. William E. Merrill, Corps of Engineers, then in charge of work on the Ohio, recommended a Chanoine wicket dam with a lock chamber 600 ft. long and 110 ft. wide, and these features were adopted.

As first proposed, the canalization project provided for a depth of only 6 ft. and covered a distance of only 90 miles below Pittsburgh. It was subsequently extended to Marietta, Ohio, 174 miles below Pittsburgh. In 1910 Congress adopted a project for the entire river which provided for a navigable depth of 9 ft. throughout by the construction of a series of low-lift movable dams, each with a lock chamber 600x110 ft.

The project was recently completed at a cost of $115,000,000, and to signalize that fact the Ohio Valley Improvement Association, composed of representatives of all the cities on the Ohio and of the principal users of the river, arranged last October a dedicatory cruise from Pittsburgh to Cairo, the President of the United States participating in the exercises at Cincinnati and Louisville.

The 1910 Project

The source of the Ohio River at Pittsburgh is 430 ft. higher above sea level than its mouth, but the fall is not uniform, ranging from 11 in. per mile in the upper reaches to 3 in. near the mouth.

The range of the Ohio River between low water and high water is large throughout its length, but reaches a maximum at Cincinnati of 72 ft. This extreme stage is rare, 50 ft. being a normal high water stage at Cincinnati. The fluctuations in discharge are equally great, ranging at Pittsburgh from a low-water discharge of 1,600 sec.-ft. to a flood discharge of 440,000 sec.-ft. At the mouth the minimum low-water discharge is 27,500 sec.-ft. and the maximum flood discharge 1,500,000 sec.-ft.

During high or medium stages there is ample navigable depth, but when the river is low it becomes virtually a series of pools separated by intervening bars. The efforts of the United States to improve the bar crossings by the construction of wing dams to concentrate the flow resulted in some increase in depth, but it became evident early in the present century that the river was dwindling in importance and that if it was to continue to be an important part of the country's transportation system, it would have to be made usable during low water as well as during high water.

The board of engineers which considered this matter prepared plans and estimates for both a 6-ft. and a 9-ft. project but after economic comparisons recommended adoption of the latter at an estimated cost of $67,000,000, this amount being additional to the cost of the locks and dams built prior thereto.

This project, adopted by Congress in 1910, provided for a series of 54 low-lift movable dams of the same general type as the Davis Island dam, each provided with a lock chamber 600 ft. long and 110 ft. wide. It was planned solely in the interest of navigation, and contrary to a widespread belief, serves in no way to reduce flood heights or to regulate flood discharge.

During the progress of the work certain changes in the project were authorized which reduced the number of locks and dams from 54 to 49. The location of the existing structures is shown on the general map of the Ohio Valley (Fig. 13), while the profile of the river (Fig. 8) shows the relative length of the pools and the pool elevations above sea level at the principal cities. As originally planned the lift of the dams did not exceed 8 ft., which required the use of Chanoine wickets about 16 ft. long. Later 18-ft. wickets were freely used, and one of the most recent dams has pass wickets 20 ft. long and a lift of 12 ft.

The location of each dam was based primarily on the suitability of the site from a navigation standpoint, and secondarily upon economic considerations such as the character of the foundations and banks and the width and depth of the river. A further condition required that the location and lift of each dam should be such as to provide a navigable depth of 9 ft. throughout the length of the pool without resort to dredging.

Six locks and dams at the upper end of the river were placed in commission before the comprehensive project was adopted, and two others, one near Parkersburg and one below Cincinnati, were nearing completion in 1910.

The remaining structures were built in the order of their usefulness: first, those in the upper reach where the slope was greatest and where they would serve also as an extension of the canalized Monongahela River; second, at points below the larger cities, where they served to create local harbors and encouraged the construction of terminals by private capital; third, by the construction of alternate dams in certain reaches which made it possible to develop, by means of artificial freshets, low-water traffic in those reaches while the remaining dams were being built.

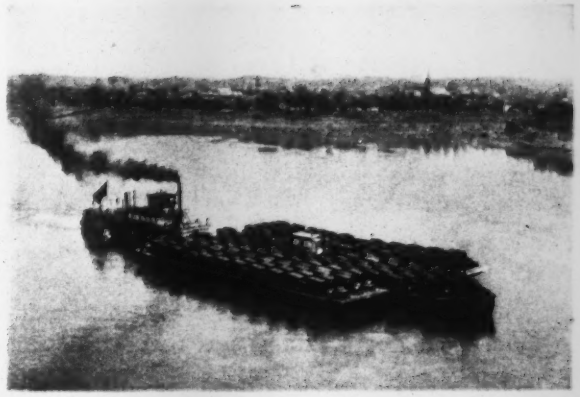


FIG. 2—SHIPPING AUTOMOBILES BY BARGE

If through traffic between points on the Ohio and points on the lower Mississippi had been the primary consideration, the Ohio as a tributary of the Mississippi should have been improved beginning at the mouth where it joined the main stream, instead of at the source, but the relative density of existing traffic on different parts of the river shows clearly that much of it is local in character and justifies in large measure the adopted order of construction.

A typical movable dam (Figs. 3 and 10) consists of a lock chamber with its longer axis parallel to and as close to one bank as is consistent with suitable approaches to the lock. Next to the river wall of the lock comes the navigable pass 600 to 1,200 ft. in length, through which boats pass when the dam is lowered. Beyond the pass lie

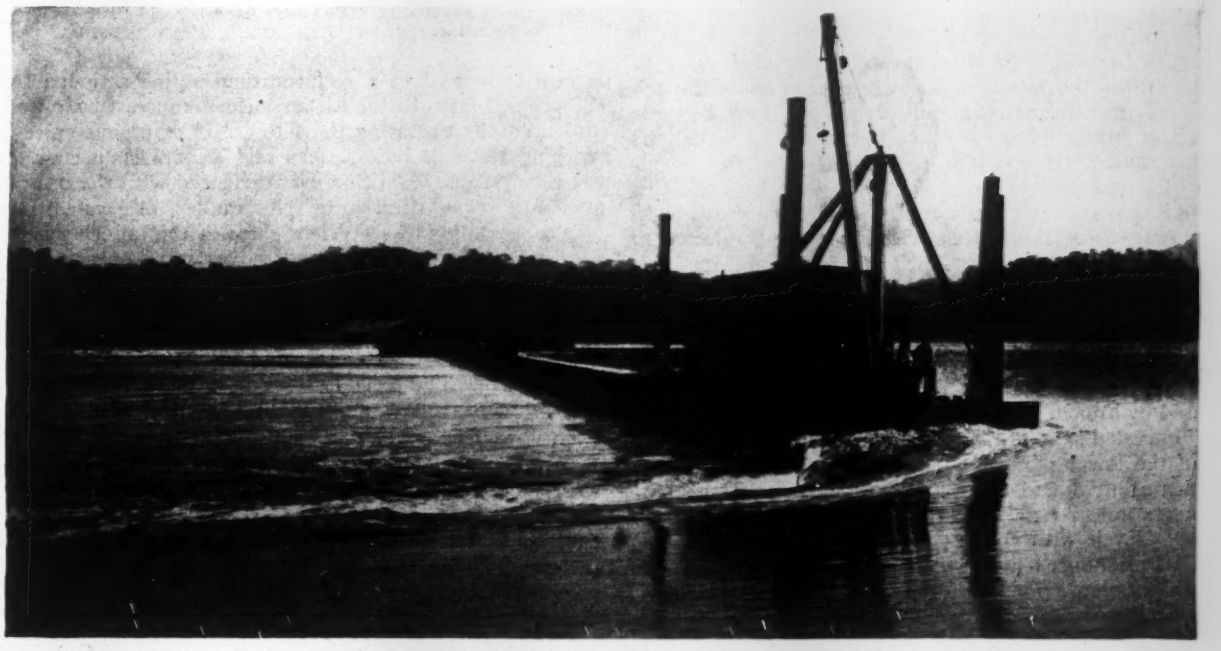


FIG. 3—RAISING A MOVABLE DAM

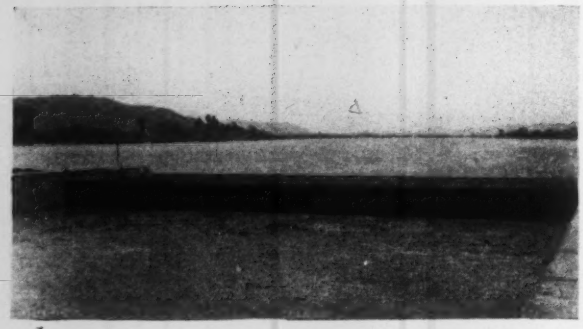


FIG. 4—ROLLING GATE CLOSED, DAM NO. 31

the regulating weirs. If these three essential elements do not occupy the entire width of the river, the remaining gap is closed by a fixed weir terminating in a suitable abutment.

The dams were planned under two governing conditions: (1) There must be sufficient area of navigable pass and weir so that when the dam is lowered the velocity in the contracted channel will not interfere with navigation. (2) The weir area must be sufficient so that the pass wickets need not be maneuvered against a head greater than 5 ft. The limiting velocity under the first condition is usually taken as 4 miles per hour at stages of 3 to 4 ft. above the pass sill.

Locks

The two locks first constructed had walls of cut-stone masonry, the next two had walls of natural cement concrete faced with portland cement, except in the lock chamber, where the walls were faced with timber. All the other locks have walls of portland cement concrete.

Where traffic is not heavy concrete walls stand up well, but in the frequent movement through locks of heavily loaded fleets of steel barges, contact with the walls is unavoidable and scouring and gouging take place. To prevent such deterioration, locks recently constructed have parts of the lock wall faces protected against abrasion by horizontal lines of cast-steel fenders bedded in concrete.

Lock Gates

Gates for all Ohio River locks constructed prior to 1916 are of the rolling type (Fig. 4), mounted on ten pairs of car wheels which roll on a steel track carrying the gate from a recess back of the land wall across the lock chamber. On most of the rolling gates the wheels are of cast iron, revolving on fixed axles. While this mounting permits of ready replacement in case of breakage, experience shows that wheels rigidly connected to revolving axles occasion much less wear on the gate tracks. In a number of cases such wear has been so serious as to require rebuilding the track. Such major replacement work is not only costly but results in considerable interference with navigation. The rolling gates, although they have been the cause of some difficulties caused by broken wheels or worn-out tracks, have in general operated satisfactorily in the upper part of the river.

In the lower part of the river, where high-water deposits of mud and sand are more extensive, the gate recesses unless tightly sealed become clogged with sediment. Even with the exercise of the greatest care an annual cleaning is necessary before the gate can be put into operation. This involves considerable expense and frequently causes delay to navigation.

The great width of the lock (110 ft.) in comparison with the height of the gates led originally to the adoption of gates of the rolling type, but because of the silting of the recesses, mitering gates were adopted in 1914 and used at nearly all locks since constructed (Fig. 14).

Ohio River locks, with a few exceptions, are filled and emptied through openings in the river wall, of which there are seventeen above the dam for filling and the same number below for emptying. Each opening is controlled by a butterfly valve on a vertical axis.

At the locks first built no advantage was taken of the water power available during the periods when the dam was up, and power for operating the gates and valves was secured from coal-burning steam plants, or from gas engines at points where natural gas was available. To provide for an emergency due to a breakdown, a duplicate unit was provided. All locks built since 1914 have a water turbine installed on the river wall which serves as a primary source of power. A land power plant is also provided as an auxiliary. These auxiliary plants are as a rule equipped with semi-diesel engines, as their operation is intermittent in character.

The rolling gates are opened and closed by a chain or cable connected to a winding drum which, in turn,

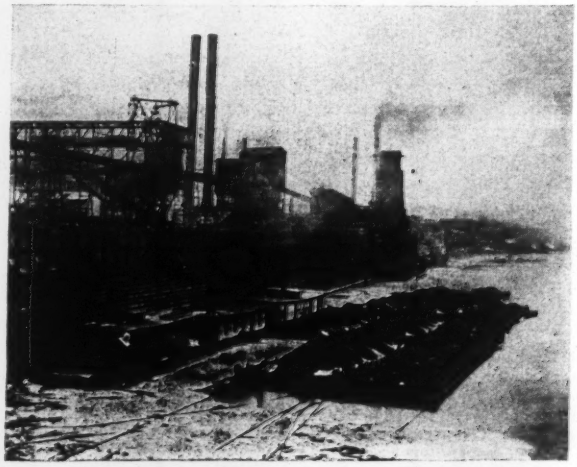


FIG. 5—COAL HOIST, CAPACITY 10,000 TONS PER DAY, JONES & LAUGHLIN STEEL CO., PITTSBURGH, PA.

is gear-connected to a reciprocating engine actuated by compressed air. In the earlier locks compressed air was also used for operating the filling and emptying valves, working through jacks, racks and sectors connected to the valve stems. Difficulties experienced with the use of air led to the substitution of a hydraulic (oil) system for operating valve jacks. When gates of the mitering type were adopted, both gates and valves were operated by hydraulic jacks using oil under a pressure of 250 lb. supplied by the main oil pump geared to the turbine or from the auxiliary pump in the land plant. The hydraulic system of lock operation is superior to the air system. The first cost is less; it is more reliable and efficient; and it gives more accurate control of the operating machines.

Navigable Pass

When the dams are down or the locks for any reason are out of commission, navigation makes use of the navigable pass limited on one side by the river wall of the lock and on the other by the weir, the foundation of which is 4 ft. to 5 ft. higher than the pass foundation (Fig. 7).

Until covered by a least depth of 9 ft., these masonry structures constitute obstructions to navigation; there-

fore the distance between them must be sufficient to permit the free and easy movement of the largest fleets. This fixes the minimum length of pass at 600 ft. In the upper river this length is sufficient to prevent undue contraction, but as the size of the river increases the length of the pass is increased, reaching a maximum of 1,250 ft. at dams 52 and 53, which are below the mouths of the Cumberland and the Tennessee.

All of the navigable passes are closed by Chanoine wickets of the same general type as those adopted for use in the Davis Island dam, which was completed in 1885.

There have been many improvements in detail that have increased the durability of the wickets, but the type remains unchanged, a heavily ironed wooden shutter, 12 in. thick, 3 ft. 9 in. wide, 16 to 20 ft. in length, hinged to the concrete base by a structural steel frame known as the "horse" and supported in its raised position by a metal prop. The horse and prop have a common hinge point on the shutter, sufficiently above the center of pressure to hold the wicket, in its raised position, under normal operating conditions.

The wickets or shutters are spaced 4 ft. center to center, leaving a 3-in. space between them. When the water escaping between the wickets exceeds the low-water flow, these spaces are closed, in whole or in part, by wooden needles. When the natural depth in the river is 9 ft. or more, the wickets lie on the concrete base, offering no obstruction to the passage of boats (Fig. 7). As the river begins to fall below this stage the dams are raised by raising the pass-wickets successively. A derrick boat provided with power, but not self-propelled, is used for this purpose (Fig. 3).

A navigable pass of 600-ft. length requires 150 wickets, and as wickets are occasionally damaged by drift, they are so attached to the base as to permit replacement by the aid of a diver. A single defective wicket or even two successive defective wickets can be replaced with the dam in its raised position, but for more extensive repair or replacement the dam is first lowered.

The weir section of the dam serves a double purpose. Primarily it is necessary to keep down the head while the dam is being raised, as the Chanoine wickets in the pass, even with the aid of a power boat, cannot be raised against a head of more than 5 ft. It must be at least large enough for this purpose and is kept open until the pass is raised. Its other function is to regulate pool levels by passing small rises in the river without manipulation of the pass wickets. The weirs used in the Ohio River movable dams are of two general types, wicket and bear-trap, a cross-section of the former being similar to a cross-section of the navigable pass, except that the sill is about 4 ft. higher and the wickets correspondingly shorter.

The standard Ohio River bear-trap weir is 91 ft. long between its limiting masonry piers and has a maximum clear opening 15 ft. deep, giving it a maximum discharge capacity of about 10,000 sec.-ft. The lower leaf (Fig. 6), made entirely of steel, is hinged on a horizontal axis at the downstream edge of the concrete base. The upper leaf, a steel frame with wooden filler, is correspondingly hinged at the upstream edge of the base and overlaps the lower leaf. Conduits controlled by butterfly valves connect the space beneath the leaves with the upper and lower pools.

Given an initial head of 2 to 3 ft., the bear-trap can be raised by closing the lower pool valves and opening the upper pool valves, and can be readily held at any intermediate position by regulating the valve openings.

Except for some trouble caused by sediment deposits under the bear-trap leaves and in the filling and emptying culverts, operation of the modern bear-trap has been satisfactory and dependable. Trouble from sediment deposits can be minimized by proper arrangement of the culverts and valves, so as to permit the flushing out of such de-

FIG. 6—BEAR-TRAP NO. 1, LOWER LEAF, DAM NO. 30

FIG. 7—TWO WICKETS IN RAISED POSITION, DAM NO. 36

posits. The first designs provided 5-ft. circular culverts lengthwise of the piers with five branch openings in the sides of the piers to the space under the leaves. Flushing under the leaves with this arrangement was, between piers, a distance of 91 ft.

To facilitate such flushing, lateral culverts in the upstream and downstream foundations were substituted for the longitudinal culverts in the piers. With this arrangement the flushing is at right angles to the axis of the dam and the distance between the inlets and outlets is 42 ft. instead of 91 ft. While the latter plan had advantages over the former for removing deposits, some trouble was experienced in removing deposits from the culverts, and a third plan has been adopted, having culverts both in the piers and in the upstream and downstream foundations, with openings to the space under the leaves leading from the latter only. The valves are so arranged that the full head of water at the dam may be applied independently to any culvert in the piers, and after those in the piers are cleared, to any culvert in the foundations. When all the culverts are cleared, the full head may be made to act under the leaves.

From an operating standpoint bear-trap weirs are much preferable to wicket weirs, but because of their relatively greater cost most of the dams are provided with two standard bear-traps, the remaining weir capacity being in the form of wicket weirs.

Automatic pool regulation has been attempted by means of Bebout wickets, which are so designed that when they trip the wickets fall to a horizontal position on the sill with their supporting irons folded under them, leaving an unobstructed opening. When Chanoine wickets trip automatically they do not lower themselves but only swing to a horizontal position, and the supporting irons (known as horses and props) remain in position and obstruct the passage of drift.

Bebout weirs have been installed as substitutes for bear-traps, generally replacing one bear-trap but in two cases replacing both bear-traps. In some cases they have been hinged so as to trip automatically at certain pool stages determined by river discharge, and in other cases they have been hinged so high that they must ordinarily be tripped by the maneuver boat. In the former case the wickets sometimes trip at a lower discharge than desired, as a result of wave action caused by boats or wind, thus necessitating additional maneuver boat work in raising wickets, which offsets the diminished work of lowering wickets. Bebout wickets can be raised against materially greater heads than Chanoine wickets, but have the disadvantage of being less durable than the latter in that their supporting irons are less rigid.

Dam 52, completed in 1928, has 540 ft. of Chanoine wicket weir, 160 ft. of Bebout weir and three standard bear-traps.

Foundations

Above dam 31 it has generally been practicable to build on rock foundation, but below that point such foundations are exceptional. There has been but one failure of a dam foundation. That occurred at dam 26, where the navigable pass failed by sliding. The foundation slab in this case was constructed upon shale and was only 3 ft. thick with a key about 16 in. deep. The shale immediately under the foundation slid upon itself as a result of internal water pressure and insufficient weight. The thickness of foundation slabs has since been limited to a minimum of 5 ft. and the depth of keys to 3 ft., while anchor rods grouted into the rock have been added as a further precaution where foundation slabs were constructed upon rock or shale of a seamy or weak character.

Of the locks and dams, 24 are on rock or shale foundation and 25 are supported in whole or in part on piles with sheet pile cutoff walls under the upstream edge of the dam foundation, the lock walls and miter sills or gate tracks.

In the earlier structures tongue-and-groove wood piles were used for the cutoff walls, but in all those of recent construction reliance was placed on interlocking steel sheet piling 30 to 40 ft. in length, depending upon the character of the underlying material.

When built on piles, the foundations are protected below the dam by a rockfilled timber crib, 20 to 30 ft.

wide, and an apron of heavy riprap 40 to 60 ft. wide below the crib. Heavy scour takes place below the riprap apron, particularly below the bear-traps. Systematic examinations are made annually, and when necessary additional heavy riprap is placed until a stable condition is reached.

Changes in the Project

Experience with the movable dams in the upper part of the river was not entirely satisfactory. The river at this point is so flashy that frequent manipulation of the dams was necessary. This, combined with the steepness of the slope, made it extremely difficult to maintain a constant depth of 9 ft.

River interests that had been opposed to fixed dams changed their attitude, and as a result Congress authorized the replacement of movable dams 1 and 2 by a single fixed dam. It is located at Emsworth, Pa., where the width of the river permitted a long crest so that the increase in flood heights was a minor consideration (Fig. 11). In addition to a lock of standard dimensions, this dam is provided with an auxiliary lock 360 ft. long and 56 ft. wide, so that navigation is not interrupted when the standard-size lock is undergoing repairs. It was placed in commission in 1921, 36 years after the completion of lock No. 1.

A second fixed dam, similar in all respects to the Emsworth dam, is now being built to replace movable dams 3 and 4 and is practically completed. These replacements are cited by some critics as indicative of the life of movable dams, but they are in reality betterments made to meet the demands of a rapidly increasing commerce.

The number of dams in the completed project was further reduced by increasing the lift and lengthening the pools, as experience with Chanoine wickets showed that the maximum length originally assumed as 16 ft. could be safely increased to 18 ft. Advantage, however, could not be taken of this development where alternate dams had first been built.

At Louisville, Ky., the originally constructed navigation dam has recently been replaced by a power navigation dam, which made unnecessary the construction of one of the navigation dams called for by the original project. This is the only point on the river where the development of power seems to be commercially feasible. The power is developed in a privately owned power house, the use of the dam being licensed by the Federal Power Commission under conditions which provide for the annual payment by the power company to the United States of an amount which includes interest on the difference in cost between the power navigation dam and a navigation dam of the same crest height.

It is worthy of note that this river-canalization project, costing less than one-third as much as the Panama Canal, took more than twice as long to build. This is partly accounted for by the fact that work could be economically prosecuted only during periods of low water, averaging not more than five months each year; and partly by the attitude of Congress, in whose eyes the Ohio River was only one of many in the United States the improvement of which was sought by local interests. In the case of the Panama Canal, time was an important consideration, as no part of the investment was useful until the whole project had been completed, while on the Ohio each lock and dam as built was put into service.

Operation

To maintain and operate the locks and movable dams, a permanent crew of nine men is employed at each of them throughout the year. This permanent crew is supplemented by four temporary lockmen during the low-water season when the dams are in commission.

The successful operation of the movable dam system requires trained personnel of high morale. Every effort is made to keep the pool stages stable. Local rains and small rises are controlled by lowering one or more of the bear-traps. If this does not suffice, part or all of the wicket weir is thrown. For greater rises it is necessary to throw part or all of the dam. This latter is a difficult and comparatively dangerous operation, often performed under the hazards of darkness, rain, cold, ice, swift current and drift. The reverse operation of raising the dams is more deliberate and less hazardous.

Economic Justification

The annual charges on the Ohio River canalization project depend on the first cost, the cost of maintenance and operation, and depreciation. The first cost was approximately $115,000,000. While the total expenditure on structures exceeded this amount, deductions should

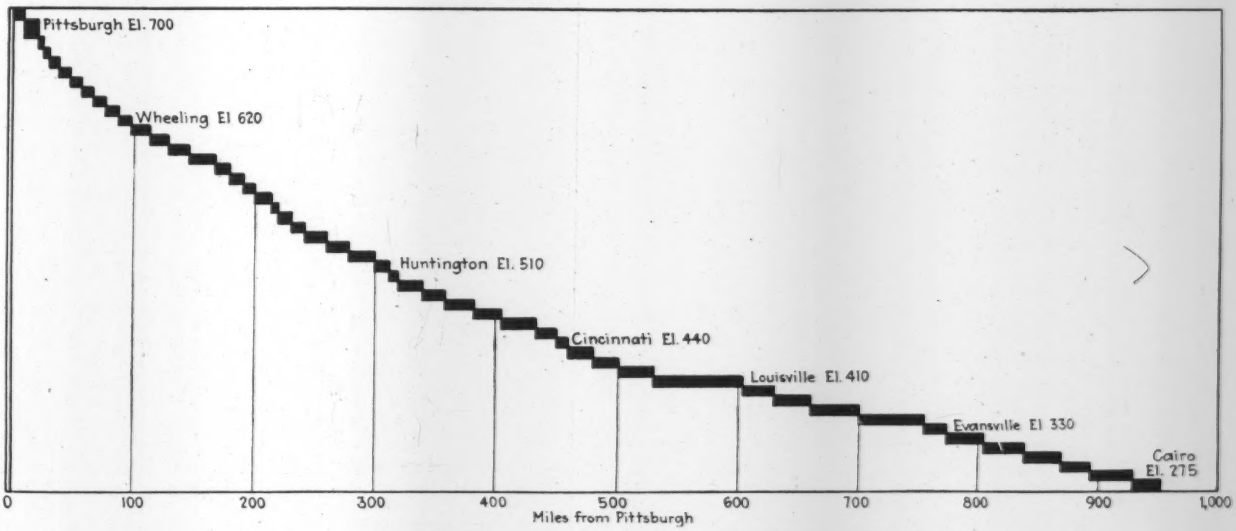


FIG. 8—CHART SHOWING SLACKWATER IMPROVEMENT OF THE OHIO RIVER

be made for the accrued depreciation, at the time of replacement, on locks and dams 1 to 4 and on dam 41, which were replaced before the expiration of their useful life in the interest of better service. Interest charges at 4 per cent, the assumed average rate at which the United States borrows money, will amount to $4,600,000.

The annual cost of operation and maintenance, including the replacement of depreciable parts, will average $2,000,000, and the estimated average annual cost of dredging in pools and in the approaches to locks and dams is $350,000. Assuming a useful life of 50 years, a depreciation or obsolescence factor on a sinking-fund basis at 4 per cent will amount to $753,000. Based on these assumptions, the annual charges will aggregate $7,703,000. No tolls are charged for the use of the river and none is contemplated, it being assumed that the decrease in transportation costs due to the use of the river will be passed on to the taxpayers, who pay the annual charges.

A project of this character is held to be economically sound when the benefits exceed the annual charges. In the past there has been no unanimity of opinion as to the economic advisability of the Ohio River canalization project. River interests naturally favored it. Railroads, while not openly opposing it, looked upon it as more or less of an experiment. In 1925 representatives of two large railroad systems publicly expressed the opinion that the project was economically unsound.

One reason for the doubt concerning the future of our inland waterways lies in their past history. In the early days of this country, before the era of railroads and when even wagon roads were few and far between, the rivers, even in their unimproved condition, provided the cheapest and most efficient means of transportation. So valuable was water transportation in those days that many of the smaller rivers were canalized through state or private enterprise, and a network of canals was built to supplement the rivers. In Ohio there were three or four canals connecting Lake Erie with the Ohio River, all of them of light draft with locks 15 ft. wide and 90 ft. long, just big enough to move a single canal boat from level to level. Most of these waterway projects represented sound investments at the time they were made and contributed greatly to the growth and development of the country, for transportation has always been an important factor in its economic life. With the advent of railroads, a form of transportation was provided which was superior to the shallow draft waterways for a large part of the commerce of the country. The canals gradually disappeared from use and traffic on the rivers was largely limited to heavy bulk commodities whose origin and destination were on or near the riverbank.

The railroads greatly contributed to the downfall of river traffic by lowering their rates below the general level where water competition was involved, and correspondingly increasing them at inland points. This chaotic state of affairs existed for many years, during which many inland waterway projects were advocated primarily as a means of reducing rail freight rates and not because economic studies had shown them to be superior transportation agencies or valuable adjuncts to existing railroads.

One important forward step was the creation of the Interstate Commerce Commission, vested with power to regulate and control rail freight rates. Supplemental legislation gave it power to establish joint river and rail rates. Another was the creation by law of a board

Commodity	Tons		Ton Miles		Average Haul	
	1927	1928	1927	1928	1927	1928
Coal and coke	18,517,714	9,160,766	682,993,438	740,122,972	78.0 mi.	80.8 mi.
Cement	48,540	85,025	5,362,674	13,347,436	110.0 "	158.7 "
Sand and gravel	9,187,007	6,749,233	137,862,357	125,117,331	15.0 "	14.3 "
Stone	386,862	425,555	11,067,823	12,806,378	28.6 "	30.1 "
Iron and steel	1,039,821	1,413,216	294,389,173	350,556,663	284.0 "	242.4 "
Oil and gasoline	205,597	322,600	24,238,452	40,533,082	118.0 "	125.6 "
Logs and lumber	474,045	394,200	11,829,035	11,483,043	25.0 "	29.2 "
Packet freight	256,207	329,955	40,373,269	45,269,679	157.0 "	137.2 "
Unclassified	12,725	57,717	6,327,344	5,450,416	497.0 "	94.4 "
Totals	20,128,518	20,938,267	1,214,490,565	1,344,687,000	60.5 "	64.3 "

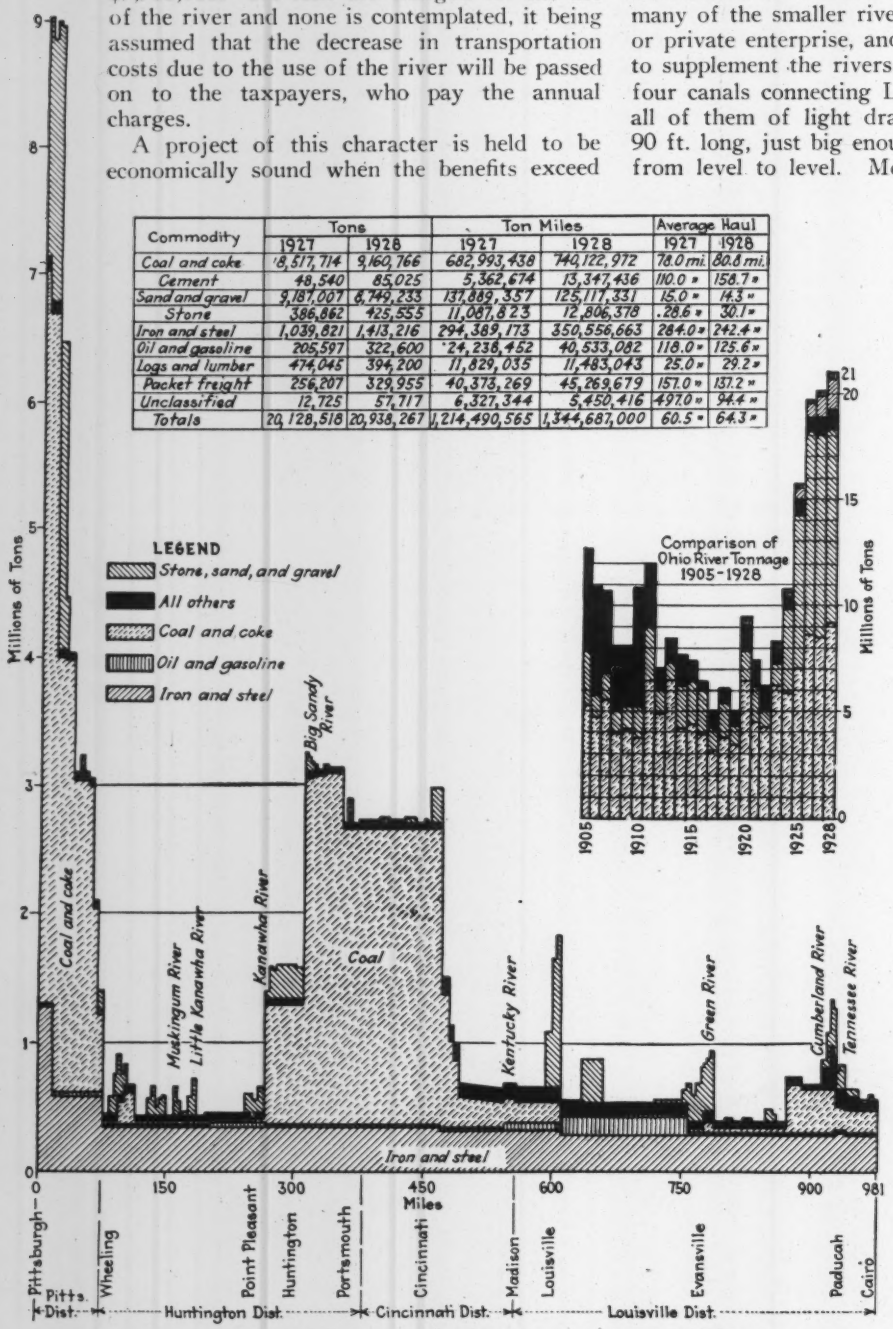


FIG. 9—OHIO RIVER TONNAGE GRAPH FOR THE YEAR 1928

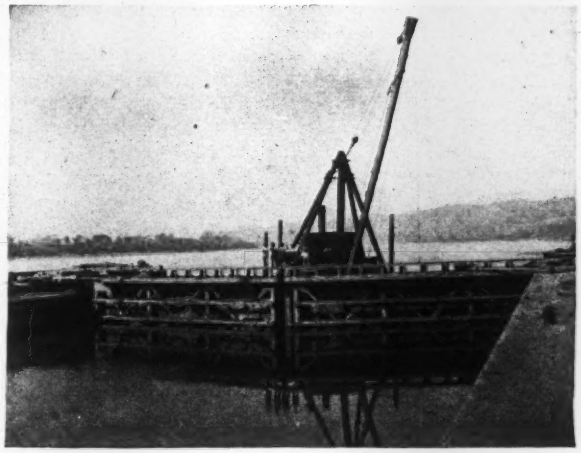


FIG. 10—LOWER GATES CLOSED, DAM NO. 39

of review in the office of the Chief of Engineers to which all new river and harbor projects must be referred and which is frequently called upon by Congress to review projects heretofore adopted. A third was the creation of a government-owned corporation to operate a fleet of boats and barges on the Warrior and Mississippi rivers as a demonstration of what was possible on a modern waterway with modernized equipment. A fourth was the general recognition of the importance of concentrating on major projects funds available for the improvement of our inland rivers. This was made possible by substituting for specific appropriations a lump sum appropriation to be allocated by the Secretary of War to projects approved by Congress and in accordance with their needs and relative merit.

By some it is held that inland waterway improvements are justified even if the direct benefits are less than the carrying charges, but in its report to Congress a number of years ago the National Waterways Commission stated that:

> The cost of facilities for carrying freight, whether borne by the federal government or by private capital, is a burden upon the resources of the country. The fundamental criterion should be whether a railway or a waterway, when constructed or improved, will be a profitable investment of capital.

Fig. 9 is a tonnage graph of the Ohio River for the calendar year 1928 and a tabular comparison of tonnage and ton-mileage with those for 1927. In 1928, coal (including a small amount of coke) constituted 43.8 per cent of the total tonnage and 52 per cent of the ton-mileage. Sand and gravel is the second largest tonnage item, but as the average haul of this commodity is only 15 miles, the ton-mileage is relatively low.

Iron and steel provided only 6.75 per cent of the tonnage and 26 per cent of the ton-mileage, 260,000 tons moving from the Pittsburgh industrial district to points on the lower Mississippi River. Except for this through movement of iron and steel, the present commerce on the Ohio is largely local in character.

Nearly two-thirds of the coal-moving on the Ohio in 1928 originated on the Monongahela River and was delivered to points between Pittsburgh and Wheeling, 70 miles distant. About 1,000,000 tons originated on the Kanawha River and 1,750,000 tons was hauled by rail to Huntington, W. Va., and transferred to barges.

Some of the Kanawha and Huntington coal is unloaded at Portsmouth and some goes as far as Louisville, but most of it is unloaded at or near Cincinnati, partly for local use and partly for reshipment by rail to points in Indiana. This rail-river-rail movement, involving two transfers and the breakage loss incident thereto, is concrete evidence that for such freight water transportation is cheaper than rail transportation. About 400,000 tons of coal moved from mines near the lower end of the river to the Mississippi. Heretofore this has been a seasonal movement. With the completion of the canalization project, it should show a marked increase.

When this project was undertaken, its success was predicated largely on an increase in the movement of coal from the Pittsburgh district to points on the lower Mississippi. The opening of other coal fields caused this movement to cease entirely in 1920, but despite that fact the total commerce has more than doubled since that date.

Except the packet freight, which amounted to 330,000 tons (1.6 per cent of the total), and the sand, gravel and stone, nearly all the commerce moves downstream with practically no back-haul. Most of it is carried in fleets of barges pushed by stern-wheel towboats. Barges are now generally constructed of steel

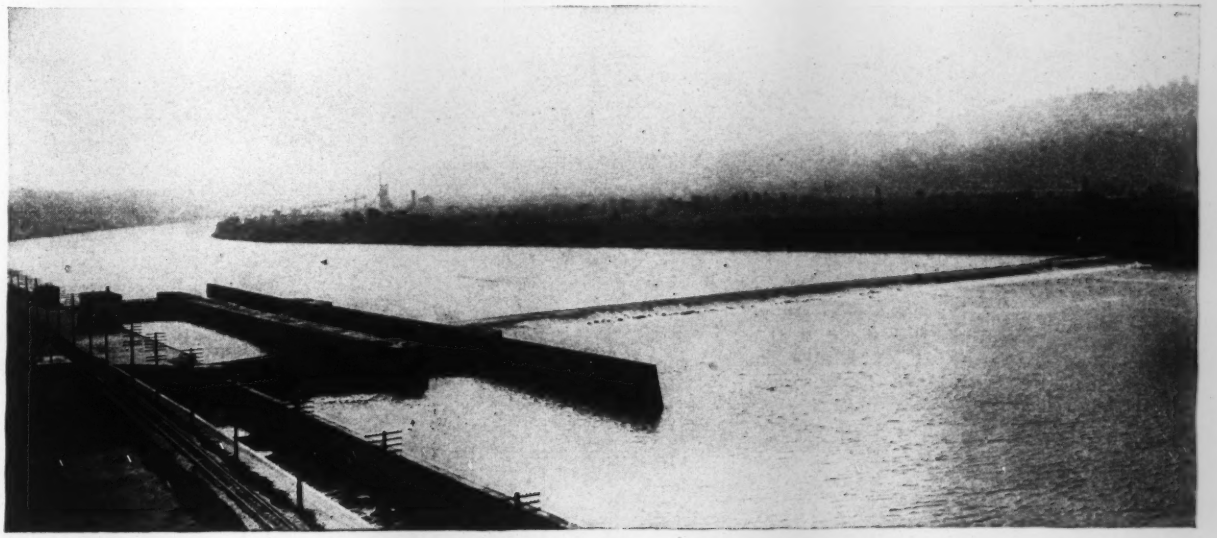


FIG. 11—EMSWORTH DAM, OHIO RIVER

FIG. 12—TOW OF STEEL THROUGH DAM 35

and the tendency in coal, gravel and steel traffic is to build hulls having a capacity of 800 to 1,000 tons. Most of them are of the open type, as only a small percentage of the commerce requires protection from the weather. Specially constructed tank barges are used for transporting oil and gasoline.

Steam power is generally used on the larger towboats, some of recent construction having compound condensing engines of 1,400 hp. Diesel engine towboats are rapidly increasing in number, the largest being equipped with twin engines of 360 hp. each. While most of the towboats, whether steam or diesel powered, are of the stern-wheel type, two of the largest diesel boats have twin-screw propellers.

During the low-water season, when the dams are in commission, tows are generally limited to the size of the locks, 600x110 ft., and the cargoes run between 8,000 and 10,000 tons. Larger tows, carrying from 12,000 to 14,000 tons, are not infrequent, but if the dams are in commission they must be broken in two for passage through the locks.

A census of boats and barges on the Ohio River and its tributaries, taken June 30, 1927, gave the following results:

	No.	Total Hp.	Average Hp.
Steam towboats	173	62,544	362
Towboats with internal combustion engines	272	14,548	54
Steam packet boats	28	6,917	247
		Total Tonnage	Average Tonnage
Steel barges	1,392	1,007,181	725
Wood barges	1,771	580,625	328

If all the barges were placed end to end they would form a line 100 miles long. Their capacity is equivalent to that of 30,000 ordinary coal cars, or a series of freight trains 225 miles long.

A rough estimate of the investment by private interests in commercial river equipment on the Ohio and its tributaries indicates that there is $40,000,000 invested in river craft and $35,000,000 in terminals.

It is customary to measure the direct benefits flowing from an improved waterway by the difference between the water-haulage cost of the freight that moves by the waterway in question with the existing rail rates between the same origin and destination applied to the same tonnage. Where such comparisons involve more than one river, the savings or benefits are prorated between the two rivers in proportion to the mileage on each. The computation of such benefits would be a very simple matter if the water-haulage costs were known, as well as the origin and destination of all shipments made by river.

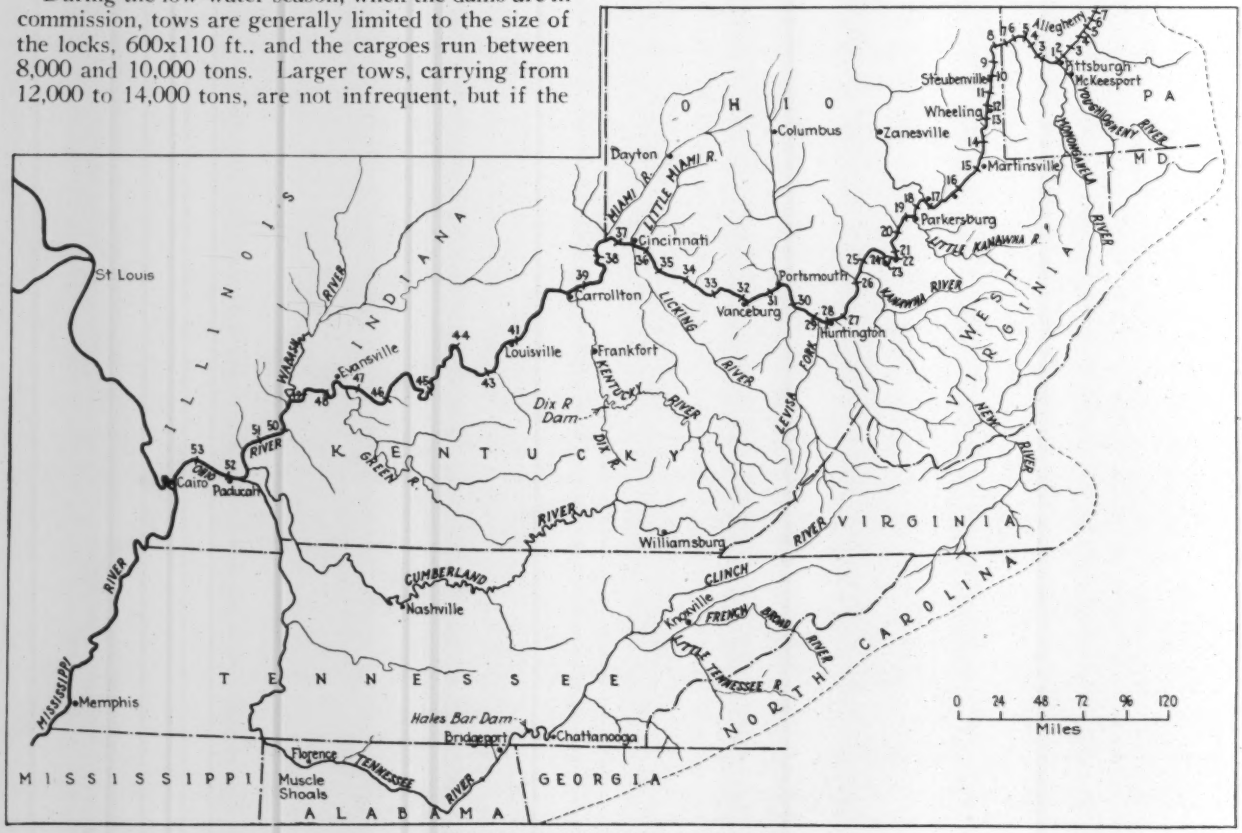


FIG. 13—MAP OF THE OHIO RIVER

TONNAGE FOR 1928 ON THE OHIO RIVER

Commodity	Tonnage	Savings Per Ton	Total Savings
Coal and coke	9,160,766	$0.375	$3,435,300
Cement	85,025	.50	42,500
Sand and gravel	8,749,233	.20	1,749,800
Stone	425,555	.25	106,400
Iron and steel:			
Long haul	350,000	3.25	1,137,500
Short haul	1,063,216	.50	531,600
Oil and gasoline	322,600	1.50	483,900
Logs and lumber	394,200	.33	130,000
Packet	329,955	.50	164,500
Miscellaneous	57,717	.25	14,500
Total	20,938,267	.....	$7,796,000

If the commerce on the Ohio was transported by common carriers the published tariffs would furnish the water-haulage costs, but as nearly all of the large movements are made by private carriers and a few contract carriers, definite information as to water-haulage costs is not available to the public. Furthermore, the costs vary so greatly with the magnitude of the movements and the length of haul that an analysis of each major movement is necessary to secure dependable information.

Such an analysis was made of the 1925 tonnage under the supervision of the writer while serving at Cincinnati as division engineer of the Central Division. The principal users of the river co-operated freely in furnishing information as to costs and plant performance, and theoretical computations of water-haulage costs made by C. I. Grimm, principal engineer in the Cincinnati office, were checked therewith.

The results of that analysis were published in tabular form in the *Transactions* of the American Society of Civil Engineers, Vol. 89, p. 1178. In preparing this table, water-haulage cost data covering a large number of movements were studied, but in order not to disclose costs of individual movements received confidentially, they were consolidated into groups and the rates and savings listed are the average for the group.

The water-haulage costs on private carrier movements included interest at 6 per cent on the investment in floating plant and on the privately owned terminal facilities, as well as allowance for depreciation. So stated, such costs are comparable with rail rates, as the earnings of the railroads are limited by the transportation act to about 6 per cent on their invested capital.

The 1925 analysis showed accumulated savings in excess of $5,000,000. Similar studies of the tonnage in subsequent years show savings for 1926 of $6,911,600; for 1927 of $7,098,600, and for 1928 of $7,796,000.

A summary of the 1928 tonnage, with the computed savings on each commodity, is shown in the accompanying table. This exceeds by $93,000 the estimated annual charges on the *completed* project.

Reports for the first eight months of 1929 show an increase of 15 per cent in the movement of coal and a net increase of 5 per cent in total tonnage over the corresponding period of 1928. As the project has just been completed, this showing augurs well for the future. Among items of prospective commerce a comparatively large movement of coal by river from the West Virginia fields to St. Louis is expected. Existing coal movements yield benefits, that may be credited to the Ohio River, ranging from 20c. to 50c. a ton. On the prospective coal movement to St. Louis the saving over existing rail rates is estimated at 75c. per ton.

For several years steel and iron products have been moved by river from Pittsburgh to Memphis and Baton Rouge when river stages permit. The large steel companies, foreseeing the approaching completion of the project, have made preparations to take advantage of the 9-ft. depth throughout the year that has now been provided. In 1928 such movements aggregated 260,000 tons. With the river completely canalized a tonnage of 400,000 is expected. As the difference between water-haulage costs and rail rates in such shipments ranges from $5 to $7 a ton, their importance to the project will be apparent.

Many of those interested in the completion of the Ohio River project look forward to such reduction in transportation costs as to make Baton Rouge and New Orleans the exporting points for a great part of the Ohio Valley instead of points on the Atlantic. Others foresee the time when iron ore will be brought by sea to Baton Rouge and barged up the Mississippi and Ohio rivers to meet the coal; but even if some of these forecasts are not realized it seems assured that the canalization of the Ohio will continue to yield benefits in excess of the annual charges and thus justify the investment.

The Ohio River's full usefulness, however, will not be realized until the railroads recognize the value of the river by granting joint rail and river rates as freely as they grant joint rail rates.

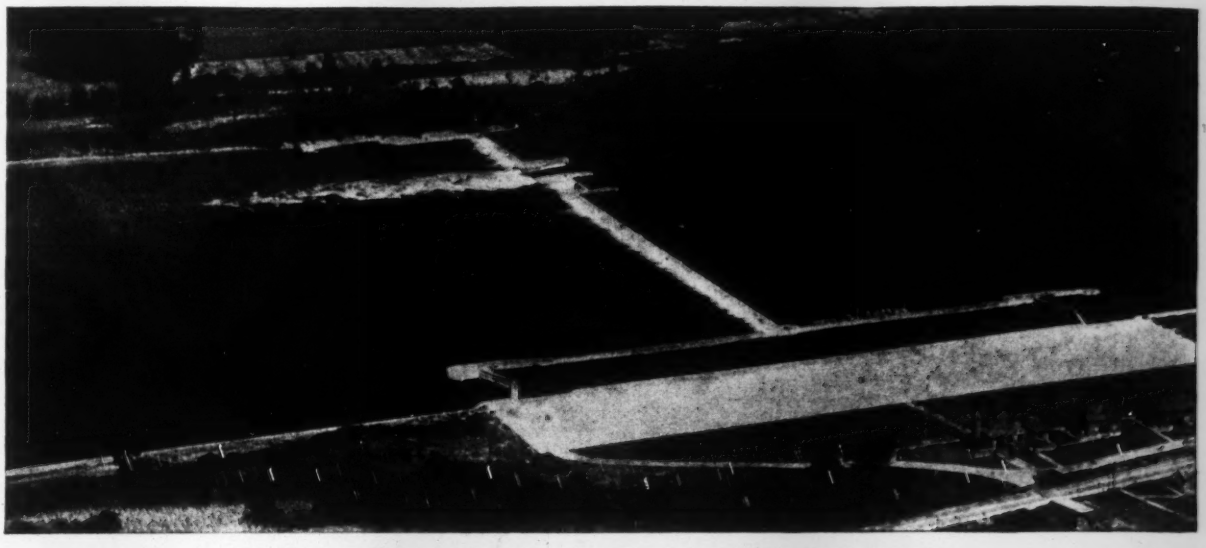


FIG. 14—MITER GATE AT DAM NO. 33, OHIO RIVER, MAYSVILLE, KY.

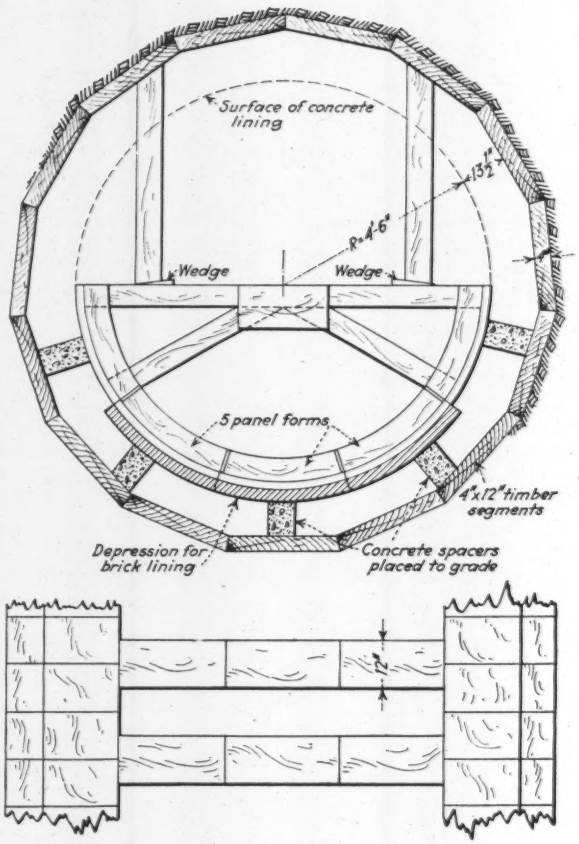
Lining the Beacon Hill Sewer Tunnel at Seattle

Circular Section Timbered With 15-Segment Ring—Concrete Poured Into Lower Half—Arch Placed by Pneumatic Process

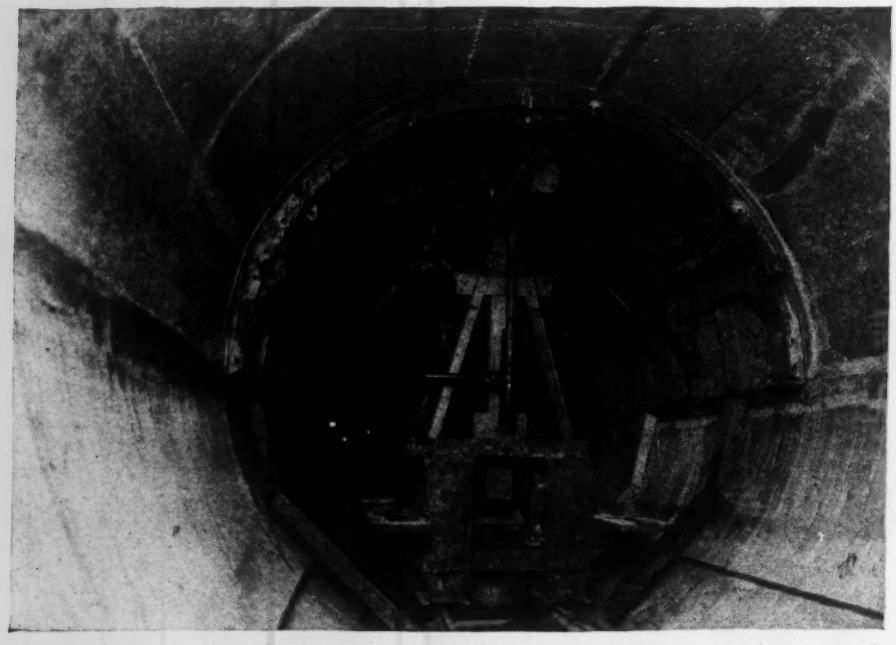
THE 5,580-ft. tunnel now being built under Beacon Hill in Seattle to convey sewage from the borders of Lake Washington to Elliott Bay is being lined with concrete to give a circular section with an inside diameter of 9 ft. Because of the stable quality of clay which the tunnel traverses, the timber lining put in as the tunnel was driven consisted of a ring made up of 15 segments, and the concrete lining is later poured inside this ring. Up to the level of the spring line, wood panel forms are used and the lower half of the concrete lining is poured by gravity from dump cars on elevated tracks. For the arch collapsible steel forms are used, and in these concrete is placed by the pneumatic process.

The present contract for completing the Beacon Hill tunnel was made after a 4x6-ft. pilot tunnel had been driven in about 3,700 ft. from the west portal to explore the formation and to determine whether excessive water would be encountered. The present operation, therefore, consists in (1) the enlargement of this pilot bore to a circular section with a diameter of about 12 ft., this size being that which would give the desired 9-ft. diameter, net, after placing the timber and concrete linings, and (2) driving the remaining 1,880 ft. to the east portal. The concrete lining is poured with a depression 2½ in. deep in the invert, in which brick paving will be laid.

For practically its entire length the tunnel traverses a dry, blue clay which holds its shape exceedingly well and is not so hard that it cannot be removed by air-driven gads. For the most part it has been found advantageous to use pointed scoop shovels to load the muck cars, although where some gravel was found in the clay, steel slick sheets and square-nosed shovels were used.



PLAN AND SECTION OF FORMS FOR LOWER HALF OF LINING



COLLAPSIBLE STEEL ARCH FORMS IN PLACE
The arch is concreted by pneumatic method, the pipe entering the crown at the opposite end of the forms.

The 4x12-in. segments for the timber lining are cut outside the tunnel to the right length and bevel required in a 15-segment ring of the prescribed diameter. Segments are put in place simultaneously on opposite sides of the bore from the spring line upward to meet at the top, where they are wedged against a crown bar run ahead over the crown of the arch. Each of the top pair of segments is nailed to the crown bar.

That portion of the ring under the invert, consisting of the three lowest segments, is placed last. Before these are put in, 10-ton ratchet jacks are used to wedge out adjoining segments on either side of the bottom to a solid bearing. Then a 4x4 is put on either side of the jack and wedged out just enough to permit removal of the jack. One three-segment set is then placed on the

POURING LOWER HALF OF LINING FROM ELEVATED TRACK
Incline to top of semicircular segments appears in background.

bottom of the invert for each pair of sets extending around the remainder of the ring, as shown in the accompanying sketch. This plan saved timber, is believed to give strength and affords a convenient means of making closure and getting a tight fit throughout the 15-segment ring.

With the timber lining in place, the next step is to place concrete blocks of the prescribed lining thickness to serve as spacers for holding the inner panel forms away from the timbering while the concrete is being poured. A series of these concrete blocks is placed at 5-ft. intervals along the invert, five blocks being used in a transverse plane as supports for the wood panel forms used in the lower half of the bore. Near the bottom of the invert these spacers are simply placed upon the timber segments; farther up the sides they are held in place by wood strips tacked onto the segments and where necessary wire stays also are used.

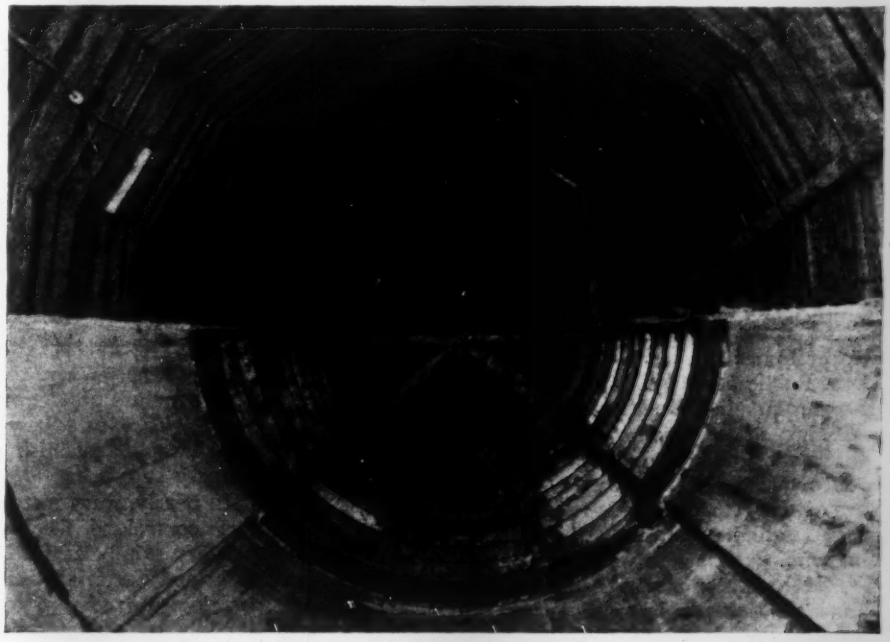
The wood forms used in the lower half of the tunnel are panels 33 in. wide by 20 ft. long, are very substantially braced and have metal straps over the joints. Of the five wood panel forms used in each set-up below the spring line, the central or invert form is of special shape and the two other pairs are interchangeable.

These panels are placed on the concrete blocks after the latter have been carefully set to grade, and then laminated semicircular webs are rested on the panels and made to bear down upon them by being wedged against the arch timbering, as shown in the sketch. The webs are not fastened to the panels. At the spring line of the tunnel are laid the timbers to support the track from which concrete is poured into the invert with the aid of small wooden chutes. From the same track concrete is delivered to the arch forms by a pneumatic gun.

Four sets of wooden invert form panels were provided for the job, and it is customary to leave each set-up in place 48 hours after pouring. For the arch, six sets of forms, of the steel collapsible type, 20 ft. in length, were provided, and thus it is possible to leave a set-up of the arch forms in place 72 hours after pouring. The arch forms are moved along on a traveler as the work advances.

A concrete-mixing plant was erected at the east portal and one gasoline and one electric locomotive are used for delivery, the concrete being taken into the tunnel in 1-cu.yd. dump cars, three or four cars to the train. Ordinarily a $1:2\frac{1}{4}:3\frac{3}{4}$ mix is used. The net thickness of concrete lining is $13\frac{1}{2}$ in.

There is sufficient space for an inspector to crawl through every set-up before pouring commences, thus making sure the specified clearances are obtained and that



FORMS AND LINING IN LOWER HALF
In foreground concrete of lower half is completed. Note arrangement of panel forms.

no foreign matter is left in the forms when pouring begins. The average rate of progress in placing the lower half of the lining has been somewhat more than 60 ft. per day. Progress in the arch is about 40 ft. per day.

The use of timber forming the lower half that requires a carpenter job on each set-up, and particularly the small capacity of the pneumatic gun, limit the progress of lining operations to relatively slow speed. However, this method keeps to a minimum royalties on the use of pneumatic placing equipment, and since completion of the project as a whole is dependent upon other factors, greater speed is not a particular objective.

To insure adequate ventilation while the gasoline locomotive is being used, an exhaust blower with a capacity of about 14,000 cu.ft. per minute was set up near the east portal, where a shaft was sunk to provide a suitable uprise for drawing air through the tunnel. The west portal was left open and the east portal was bratticed so that the blower would pull air entirely through the bore.

The work is being done under the direction of W. D. Barkhuff, city engineer. I. W. Embury is district engineer in charge of the district in which the Beacon Hill sewer is being built. Contract for enlarging and lining the tunnel, which is to be completed in March, 1930, is held by the George Nelson Co., of Seattle. C. W. Gehrke is superintendent of construction on the tunnel.

Cross-Connection Elimination War in Texas Cities

Co-operative Water-Supply Protection Methods in Dallas Reviewed—Houston and San Antonio Beginning Action

By W. N. Dashiel and Edgar Whedbee
District Sanitary Engineer, State Department of Health, and Assistant Water Supply Engineer, Dallas Water Department

THE Texas department of health takes the position that cross-connection of any public water-supply system with any other supply except an approved public water-supply system is potentially dangerous. Cross-connection surveys are being urged to obtain data which may lead to the prompt elimination or satisfactory correction of all cross-connections. There are no statutes prohibiting such cross-connections and none of the larger cities in the state has seen fit to adopt city ordinances or water department regulations to prohibit them or to provide for the adequate protection of the city supply where such connections are found. Progress toward control has been made through an educational program conducted by the state department of health with the co-operation of the domestic quarantine division of the U. S. Public Health Service in its certification program of water supplies used by interstate common carriers.

During the spring and summer of 1929 the Dallas water department, co-operating with the Texas department of health, conducted a cross-connection survey as a part of the campaign which Dallas is making to correct various sanitary defects in the public water-supply system with the view to obtaining unconditional certification of its water supply on the basis of the Treasury Department standards. There were no records available at the beginning of the survey other than a list of 184 possible cross-connections which had been compiled by the Dallas health department and additions made at intervals by the water department without any confirmation by field investigation.

The procedure adopted was to visit all premises listed and make inquiries as to the nature of water connections and whether a secondary supply was being used. Where cross-connections existed, a sanitary survey of the secondary system was conducted and all existing sanitary defects as well as a description of the physical layout were recorded. Detailed sketches of the cross-connections were made, showing points of interconnection, size of lines, valve control provided, static pressure of the secondary system at the points of cross-connection and any other pertinent information. Several cross-connections were located on premises where the parties responsible were unaware of their existence. In every instance where a secondary supply was found, considerable time was spent in definitely establishing the separation of the two supplies.

As a result of the survey, 44 cross-connections were definitely located, of which number eight were readily eliminated. There were four shallow dug or driven well supplies encountered and three cross-connections with grossly polluted water.

The remainder of the group, which comprises by far the greater portion of the secondary supplies, may well be compared with the primary supply from the standpoint of potability and safety. These deep wells were formerly artesian and only in recent years has resort been had to pumping. With but one or two exceptions, air lift is used. The wells are 950 to 2,600 ft. deep, and the water from any of them is generally regarded as bacterially safe. Many serious sanitary defects were observed in the well layouts throughout the survey, however, which would not be tolerated at a municipal well supply.

Many of the wells were subject to flooding by storm-water or by stoppage of sewers or basement drains. Many were not properly cased to prevent contamination. Many of the ground reservoirs into which the wells discharged were open and subject to surface contamination. Some of these reservoirs had concrete covers flush with the basement floor of the building and subject to floor drainage. Persons were found sleeping, eating and living immediately over and around these uncovered reservoirs.

Another striking feature was the lack of interest displayed by the building managers or engineers in the quality of their own drinking water. Some had never investigated the layout because of the inaccessibility of the various units and expressed distinct surprise when these serious sanitary defects were pointed out.

There were no double check valve installations, and single cast-iron checks were the usual protection afforded the city supply where the connection was evidently maintained for fire protection. Other connections were without check valves, where the manipulation of one or two gates would establish an open connection with the primary supply.

In nearly every instance there was no periodic laboratory control of the water. By way of contrast, the primary supply of Dallas is analyzed daily, both chemically and bacterially, under the supervision of the bacteriologist in charge of water purification and also in the city health department laboratory.

A brief description of three of the cross-connections located in the Dallas survey are given as typical:

Abstract of papers read before the Texas Water Works Short School in Abilene, January, 1930.

1. One office building surveyed maintains a well to supply water for domestic consumption, fire protection and make-up water to a swimming pool on the fourth floor of the building. The water is amply protected, both at the well and at the covered concrete reservoir into which the well discharges. The reservoir is in the basement and from it the water is re-lifted to the building distribution system and open gravity roof tanks. The swimming pool, which is of the recirculating type, is filled by a pump, which is directly connected with both the city supply and the secondary supply in such a manner that the pump may be used to boost the city water into the building system in case of fire emergency. There are no check valves between the two water supplies. This cross-connection is a very serious menace, as contamination of either supply could occur by leakage of a single gate valve or by the valve being accidentally opened. The secondary supply is particularly in danger of contamination from unsterilized swimming pool waste water.

2. A cotton gin machinery plant surveyed maintains a secondary water-supply system obtained from a deep well on the premises used for fire protection and industrial purposes. The well is very poorly protected, water from it is discharged into a 6,000-gal. open cypress tank in a small adjoining building. Water is re-lifted from this tank by a motor-driven centrifugal pump to a 75,000-gal. elevated steel tank in the yards which supplies the industrial and fire protection systems. There is a separate riser for each of the two distribution systems and the piping is connected in such manner that about two-thirds of the elevated tank capacity is reserved for fire protection at all times. There are two cross-connections; (*a*) A city line with meter is directly connected with the industrial piping system, separated only by two gate valves; and (*b*) an 8-in. city fire line is connected with the fireplug and sprinkler distribution system of the secondary supply. This latter connection is equipped with an 8-in. gate valve which is kept open at all times and a single 8-in. cast-iron check valve to protect the city supply. The static pressure at both of these interconnections is approximately 50 lb. per sq.in. The secondary system in this instance is not used for drinking water.

3. A laundry surveyed maintains an independent water system solely for supplying water for the laundering processes. This secondary supply is obtained from a deep drilled well, amply protected against outside contamination. The water is discharged from the well by gravity to an 18,000-gal. concrete covered reservoir in the building, which is subject to outside contamination from the building floor directly above it. Water is re-lifted from this reservoir to the distribution system and a covered wooden gravity tank about 90 ft. high. A 2-in. city water service line with meter on the premises supplies water for domestic consumption. A 1-in. branch line from the city supply is cross-connected with the building distribution system and the connection is controlled by a single 1-in. gate valve. There are no check valves other than the meter to protect the city supply.

As the three principal underground water reservoirs around Dallas are diminishing very rapidly, it is unlikely that any new secondary supplies will be developed. There are, however, some 32 deep well supplies which are cross-connected to the primary supply.

The city of Houston is also conducting a survey and elimination program similar to the one which Dallas has just completed. Detailed sketches of each layout are being made and separation of quite a number of supplies has been effected. It is also reported that two or three corrections have been made in Galveston, as well as numerous other smaller cities. Reports have also been received from the manager of the city water board of San Antonio stating that a resolution has been passed by the board prohibiting future cross-connections between a private supply and the city water supply. The report further states that a preliminary survey of all cross-connections has been made and disconnection of three supplies which were not in use has been completed. The city health department also is making regular monthly bacterial examinations of the water and a definite program for the future elimination of all the cross-connections is under way.

Methane Produced by Digestion of Cornstalks

Waste Utilization Suggested by Studies on Sewage Sludge—Gas Obtained That Is Suitable for Power Production

POWER production through the use of methane produced by the bacterial fermentation of cornstalks was envisioned by A. M. Buswell, of the Illinois State Water Survey, in a paper read before the Western Society of Engineers in Chicago on March 3. In the course of the studies made during the past five years on the gas produced by sewage sludge-digestion tanks, it was determined that the addition of cellulose material, such as cornstalks, would result in an increased production of methane. Further investigation showed that the gas could be produced in considerable quantities from the digestion of this latter material only provided there was sufficient nitrogenous material added to maintain the life cycle of the organisms.

The most serious problem to be solved in the course of the study was the prevention of acid fermentation, which is invariably accompanied by a thick scum floating on top of the sludge. It was found that under such conditions the acidity of the tank's contents was concentrated almost entirely in this scum and that dilution of this portion with the liquid below it would maintain the proper chemical environment for methane production. This dilution was accompanied by drawing off some of the liquid from beneath the scum and allowing it to be returned to the tank in the form of a large stream directed against the top surface.

In the digestion of cornstalks, the fermentation process must be started by the assistance of an active sludge, such as might be obtained from domestic sewage. Thereafter the digestion process can be maintained by the addition at regular intervals of small quantities of this material. The gas produced from the digestion consists of methane and carbon dioxide, and has a thermal value of about 550 B.t.u. per cubic foot. It is estimated that about 10,000 cu.ft. of gas can be produced from a ton of cornstalks.

The pith contained in the stalks, constituting about 35 per cent of the total weight, is the part that is digested and productive of methane. The fibrous material remaining after the process is suitable for use by the paper and textile industries.

Winter Paving With Asphaltic Concrete on Macadam Base

Six Rollers Following on the Heels of Extra-Size Spreading and Raking Crews Got Asphalt Down Hot in Weather Hovering Around Zero Temperature

By Walter H. Flood
Walter H. Flood & Co., Chemical Engineers, Chicago, Ill.

THE successful construction of asphalt pavement under extreme exposure to cold is illustrated by the surfacing this winter of a section of the Leif Eriksen drive along the lake front in Chicago. In this operation 67,000 sq.yd. of 2-in. asphalt surfacing was laid in eight days, during which the temperature exceeded freezing on only one day. The success of the operation was due to fast spreading and raking an extra hot mixture, followed by immediate and rapid rolling made possible by an outfit of six rollers. In view of the general practice of discontinuing asphalt paving with the setting in of cold weather, the details of the operation deserve attention.

The work consisted of laying a 70-ft. pavement of 2-in. asphaltic concrete on a 10-in. waterbound macadam base constructed in two layers—one 6 in. and one 4 in. The subgrade was a sand fill pumped in from the lake. The contract price for the pavement was $278,630, or about $2.98 a square yard. The general contractor was the McGrath & Swanson Construction Co., and the R. F. Conway Co. was the contractor for the asphalt surfacing. Construction was begun Sept. 1, 1929, and on Nov. 28 the asphalt surfacing was started. On account of the freezing weather, macadam base construction had to be discontinued, leaving some 25,000 sq.yd. not fully completed. The asphalt surfacing therefore amounted to about 67,000 sq.yd.

Mixture and Mixing Procedure

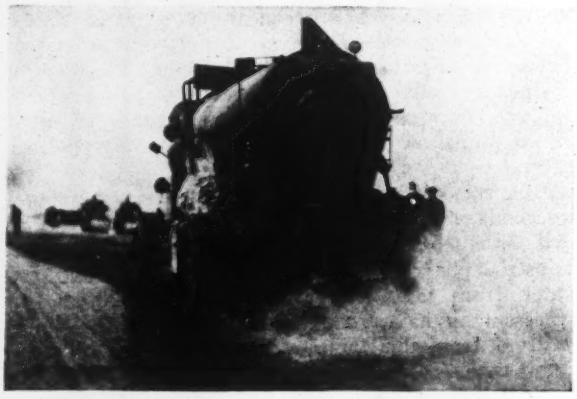
A Mexican asphalt with a penetration of 54 was used. The mixture was approximately 48 per cent limestone, 30 per cent sand, 15 per cent filler and 7 per cent asphalt. The box weights were: stone 975 lb., sand 600 lb., filler 290 lb. and asphalt 135 lb., making a 1-ton batch.

Samples of the mixture were taken several times each day and tested for percentage of bitumen and grading of aggregate. The average of the samples was approximately as follows:

	Per Cent
Bitumen	6.9
Passing 200 mesh sieve	12.7
Passing 80 mesh sieve	10.2
Passing 40 mesh sieve	13.2
Passing 10 mesh sieve	6.7
Passing 4 mesh sieve	20.8
Passing 2 mesh sieve	29.5

This type of asphaltic concrete, containing approximately 50 per cent of stone, has been used extensively for many years by the South Park commissioners, under whose jurisdiction the road was built, and has given excellent service. Practically their entire system of boulevards and park driveways is paved with this material, there being almost no other type of asphalt used for so-called permanent surfacing.

Two mixing plants were operated, one 13 or 14 miles from the work and the other 5 or 6 miles. Their operating procedure was normal except for cold-weather precautions. The aggregates were badly frozen and could not be handled from the cars as received. It was necessary to thaw out the frozen material as much as possible; although the sand could be broken up to some extent with picks, the lumps caused considerable trouble by jamming in the elevators. The stone could not be broken up even by dropping the crane bucket on the cars, and it was necessary to run a steam line through them. A line of pipe was run the entire length of each car, and from this pipe a number of short lengths drilled with small holes were run down into the car. The cars were covered with tarpaulins, which held in the heat. In this way several cars could be thawed out at once and unloaded. The material was used so fast that it did not get time to freeze again before it was run through the plant.



SEAL COAT PLACED WITH PRESSURE DISTRIBUTOR

The mixture was transported to the work in metal-lined trucks, each holding eleven boxes, or 11 tons. Because of the cold weather the temperature of the mixture as it left the plant was kept at about 375 deg. F. Even on the long haul only about 15 deg. was lost in transportation, so that the mixture as it arrived on the work was around 360 deg. Weather conditions were chiefly an obstacle in placing and rolling the asphalt.

Weather Conditions

Some idea of the adverse weather conditions during the eight days of surfacing operations is given by the weather bureau records, between 6 a.m. and 5 p.m., as follows:

Date	Maximum, Deg. F.	Minimum, Deg. F.
Nov. 28	20	15
Nov. 29	8	1
Nov. 30	17	1
Dec. 1	29	20
Dec. 2	16	8
Dec. 3	17	1
Dec. 4	28	12
Dec. 5	45	28

While the low temperatures were bad enough, an extremely high wind further increased the difficulties of

This article has been greatly condensed and rearranged from a paper read before the Illinois Society of Engineers on Jan. 24, 1930.

FOUR 11-TON ASPHALT TRUCKS DISCHARGING SIMULTANEOUSLY

handling the materials, not only by rapidly chilling the mixture but also by hampering the men, especially on the coldest days. On the morning of Nov. 29, the second day, the rollers were frozen and work was delayed until they could be put into condition. Subsequently the rollers were run each night into a garage about a mile from the work, and repetition of the trouble was avoided.

Placing and Rolling Procedure

Before the mixture was dumped, the base was broomed to remove any loose stones and other material. Two gangs of fourteen men each, six rakers and eight shovelers, handled the hot mix as it was dumped. There were no curbs or headers along the sides of the roadway, the earth berms serving to retain the pavement material, and the mixture was spread and raked to meet the berms. Frequently four trucks, or 44 tons of asphalt mix, were dumped at one time, making a spread of about 400 sq.yd.

Six rollers, weighing from 8 to 10 tons, were used in compressing the top. On account of the cold weather and high winds which swept across the site of the work, which was entirely open and unprotected, the mixture chilled rapidly as soon as it was spread, and it was necessary that rolling be begun as soon as possible and be continued uninterruptedly in order that the mixture would hold sufficient heat to secure thorough compression.

The surface of the pavement closed up well under the rollers, and there was but little hair checking or honeycombing. There was no displacement of the mixture under the roller, so that it bonded well to the base. The principal difficulty encountered was to secure a smooth, even contour, since the mixture stiffened as it cooled and was hard to rake. Considerable care was therefore required to maintain the mix at a uniformly high temperature at the plant and to handle it as rapidly as possible upon reaching the street.

The severe weather conditions rendered the ordinary hand method of applying the seal coat out of the question, since it would be quite impossible to spread a thin coat of asphalt uniformly with pouring pots and hand squeegees at the low temperatures which prevailed. Moreover, at the speed at which the mixture was being spread, this method was too slow. A pressure distributor was therefore used, the weight being readily carried on the pavement without marking, since the rapid cooling of the mix hardened it almost immediately after final rolling. This was the only feature of the work where the cold weather acted in a favorable capacity, and the contractor was enabled to follow with the seal coat close up on the final rolling of the mixture. For the seal coat a soft asphalt of similar quality to that used in the body of the pavement was employed, except that the penetration was about 120. Immediately after the application of the seal coat, granite chips from $\frac{1}{4}$ to $\frac{1}{2}$ in. in size were evenly spread by hand and thoroughly rolled in. About 15 lb. of chips per square yard of pavement was used. The chips were previously dried and heated, so that they adhered well to the asphalt skin coat.

Progress and Working Force

The total yardage completed measured 67,103 sq.yd., leaving about 28,000 sq.yd. of the original contract yet to be topped with asphalt. A total of 67 men were employed in the street crew, including seven engineers, twelve rakers and sixteen shovelers. It required 27 trucks to transport the mixture, fifteen operating on the long haul and twelve on the shorter haul. An idea of the speed with which the work progressed may be gained by the fact that the 67,103 sq.yd. was laid in eight days, beginning Thanksgiving day, Nov. 28, and ending on Thursday, Dec. 5; this included Sunday work, Dec. 1. The biggest day's run was the first, when 97 loads, or 1,067 tons, equivalent to approximately 10,000 sq.yd., were laid. The average daily run for the entire job was 8,388 sq.yd.

The usual asphalt paving contract, especially in the smaller cities, proceeds at the rate of about 1,500 to 2,500 sq.yd. of 2-in. top per day, which is about the average plant capacity encountered, the larger yardages being obtained under the more favorable conditions, such as good weather, short haul, etc. When these figures are compared with the daily average of 8,400 sq.yd. maintained for the eight days required to complete the present project, it can readily be seen that the rate of progress was exceptional.

General Discussion and Conclusions

It is believed that the speed with which the asphalt top was laid constitutes a record run for this amount and class of construction, especially when the weather conditions are considered. The question naturally arises whether sufficient compression was obtained under such extremely low temperatures as prevailed on three of the days where the thermometer fell to 1 deg. above zero. Even on the five other days the temperatures were far

SIX ROLLERS FOLLOW CLOSE BEHIND SPREADING CREW

below those usually met in paving construction, and it will be noted that only on the eighth or last day did the maximum temperature reach 32 deg. Samples cut from the pavement each day showed a density of 2.371 to 2.408. This was from 97 per cent to 98.5 per cent of the theoretical density calculated from the components of the mixture.

While the construction of asphalt pavements in extremely cold weather is not advocated as best practice, and in fact may in many cases bring disastrous results, this project is an indication of what it is possible to accomplish with the facilities afforded by a large and competent construction organization. No other type of so-called permanent pavement could have been successfully laid under the prevailing weather conditions; only rain and wet snow can actually prevent the building of asphalt when ample facilities for handling the materials are provided. It may be noted here that more than 1 in. of snow fell on Sunday, Dec. 1, the fourth day of the run. This was easily swept off and did not interfere with the work.

In laying asphalt successfully in cold weather, the principal essential is to maintain a uniformly high rate of progress, in order that the mixture may not become too chilled to secure sufficient compression, and to avoid frequent joints. Naturally, this requires not only large plant capacity but also ability to handle the material as fast as it arrives on the street. The average asphalt plant mixes from 1,000 to 1,200 lb. in a batch, and uses trucks holding from eight to ten batches, or 4 to 5 tons. As it requires about the same time to mix a small batch that it does to mix a large one, the daily capacity of a plant is largely governed by the size of the batch, provided, of course, that the drum and kettle capacities are requisite. It is obvious that the smaller batches and loads will cool more rapidly than the larger ones, not only during mixing and in transit but more especially after the batch is spread and raked on the street; and since the smaller loads will cover less yardage, there are delays in waiting for loads to secure sufficient area of material before it can be rolled. This will do no great harm in summer unless the delays are too lengthy, as the mixture holds its heat so long in ordinary weather that it is usually necessary to wait to allow it to cool somewhat before the rollers can go on it; but in cold weather, when the mixture chills rapidly, it is essential that the entire work proceed continuously at a rate of speed sufficient to prevent excessive cooling before it can be rolled.

What the Future Demands of Highway Equipment

Its Part in Increasing the Efficiency of Road Building, and Some Problems Which It Presents

By W. T. Chevalier
Publishing Director, Engineering News-Record, New York City

FOR some years past we have been selling highways to the people on a vast scale, but we know that the present readiness to buy cannot be expected to continue indefinitely. It is not quite so easy now to raise money to build highways as it was ten or fifteen years ago, or perhaps even five years ago. Financing improved highways will not become any easier. All this means that upon each element of the highway industry rests the responsibility for making the highway dollar go much farther than it has gone heretofore.

Improvement in construction efficiency during the last twenty or twenty-five years has been mainly a matter of methods—of materials and equipment. The fundamental principles involved in engineering construction have not greatly changed; the economies that we can effect in design are not great. But we have been able to achieve great economies in construction and maintenance because we have had made available to us a wonderful arsenal of tools and machines that have replaced human labor by mechanical labor. We have been able to multiply the productivity of the worker engaged in every department of engineering construction work.

The contribution made by the manufacturer of equipment has enabled the worker, whether he be engineer, contractor or workman engaged in highway construction or maintenance, to increase his output, thereby to realize a greater return on highway investment, and so make it profitable for the American people to finance this continuing program of highway construction and maintenance. And I am satisfied that the future of the industry for the next five or ten years will be measured only by the ability of the engineer, the official, the contractor and the manufacturer to co-operate, not alone as they have heretofore, but even more closely and more intelligently, so that each can reap the benefit of what the other can contribute toward this very vital problem, which becomes the more complicated as time goes on.

Equipment manufacturers have three lines of attack on their problem. One is constant research and experiment to develop improved products. The second is improved manufacturing facilities. The third is more helpful sales and service facilities.

In every type of equipment we are offered new models almost annually to keep abreast of the need. Old models are constantly improved and refined, made faster, more accurate, more sturdy. With the greater investment required, the present effort of the user must be to insure the maximum number of operating hours and a proper balance between useful life and rate of obsolescence.

Servicing equipment and keeping it ready to do the day's work is a burden that manufacturers and their distributors have been forced to assume in this day of growing necessity, to insure the maximum number of operating hours in order to earn a fair return on the cost of the machine. You cannot afford to take a $15,000 machine and let it lie idle while you are waiting for a part or a service. You must get operating hours out of your equipment if you are going to earn the interest on your investment. And so the manufacturer and his representatives have assumed the burden of servicing the equipment and of doing what they can to insure its being always ready to deliver what you hoped to get when you bought it.

Extracts from an address before the American Road Builders Association, Atlantic City, N. J., Jan. 14, 1930.

Missouri County Plans Systematic Modernization of Highways

With 350 Miles of Macadam Roads Going to Pieces Under Traffic, Jackson County, Missouri, Begins Replacement With Co-ordinated System of Concrete, Bituminous and Retread Highways

By William M. Spann
Field Engineer, Jackson County Highway Commission
Kansas City, Mo.

JACKSON COUNTY, Missouri, has stepped to the front rank in highway improvement by putting under construction a modern road system in keeping with its agricultural, industrial and commercial development. With an area of 607 square miles and a population of approximately 400,000, the county in 1928 had some 350 miles of old macadam roads. Rapidly increasing motor traffic made maintenance costs so high that some drastic action became necessary. Accordingly in May, 1927, E. M. Stayton and N. T. Veatch, Jr., of the firm of Black & Veatch, consulting engineers, Kansas City, Mo., were appointed a bipartisan board by the County Court to prepare a report recommending a definite step to be taken. This report was made, and in May, 1928, a bond issue of $6,500,000 was voted for a complete highway system to be built under the direction of the board.

Jackson County has a rainfall of 24 to 50 in. a year, and an average snowfall of 25 in. The average date of first frost is Oct. 23, and of last frost April 10. The rocks of the county consist largely of limestone shale and sandstone; the soils are loess, residual limestone and shale, and alluvial soil. The general surface is a rolling upland, the drainage system flowing into the Missouri River.

Many of the construction materials are secured locally. Crushed stone is secured from the Bethany Falls limestone. It has a French coefficient of wear of 7, and modern plants furnish the stone in satisfactory quantity and quality. Sand of good quality comes from the Kaw and Missouri rivers. Several plants manufacture cement from the local limestone deposits.

From Kansas City five state highways radiate to the north, east and south through Jackson County. The county highway system is built around these state highways as a base, as indicated by the accompanying map (Fig. 1), and connects with all the boulevards of the city and the main highways in the adjoining states and counties. The outstanding elements of the system are:

1. An inner belt for the distribution of traffic just outside the corporate limits of Kansas City. Traffic will move along this belt and enter the city on that road or street leading directly to its destination.

2. An outer belt for the distribution of traffic near the south and east county lines. Traffic entering the county will be diverted by the belt to a direct route to its destination.

3. The Blue River Valley route, which has scenic possibilities that cannot be surpassed. This scenic drive will also open up a new territory for gardening and industrial development.

4. Sufficient roads to connect these belt lines of the

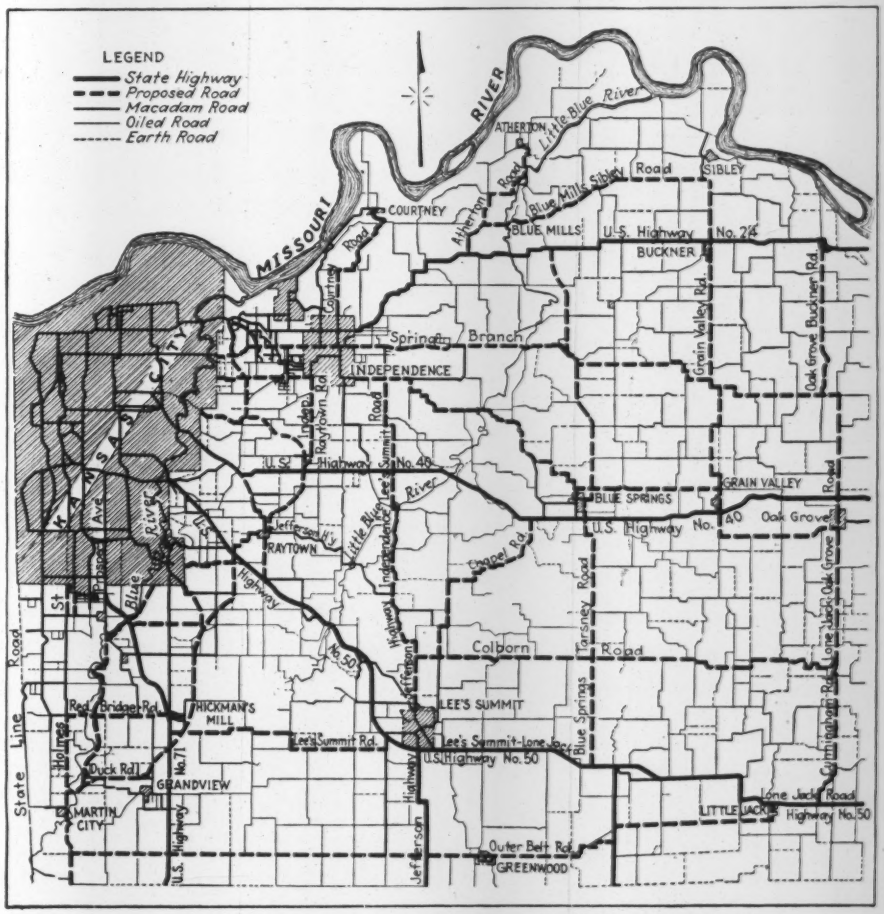


FIG. 1—IMPROVED ROAD SYSTEM FOR JACKSON COUNTY, MO.

county and state highways at frequent intervals and at all important points.

As laid out, the system of 224 miles contemplates the maximum use of existing roads. The location keeps to a maximum grade of 7 per cent and a minimum sight distance, vertical and horizontal, of 400 ft. All curves are superelevated for a speed of 35 miles per hour; all curves of 10 deg. and over are widened, and grade separations are made wherever possible at intersecting railroads and highways. Where grade separation is not practicable, the Cook County intersection is used. This intersection widens the pavement on both roads for 300 ft. to four traffic lanes, with 30-ft. radii at the corners.

Three types of construction were decided upon: (1) concrete, Bates type, 9-6-9 in., where complete reconstruction is necessary; (2) asphaltic-concrete resurfacing, where the base is full width and in good condition; and (3) retread, where the old macadam is in various stages of repair and a road of low cost is wanted.

The roadbed in each case is graded to proper section and profile, care being taken to get perfect drainage. Existing culverts are used whenever possible. Some subdrainage is used on account of stratified rock underlying the subgrade in many cuts.

Road Structure and Construction

Laboratory control is maintained on all materials; inspection is made at the point of origin, if possible, to avoid delays and rejection after shipment. Test beams are made of all concrete; these beams are broken on the job, using a portable machine. Cores are taken from all concrete pavement before payment is made, to determine thickness and compressive strength.

Concrete Roads—Concrete roads are built to the standard Bates section, using a ¾-in. premold expansion joint every 100 ft. and a contraction joint, formed by a plane of weakness, half way between expansion joints. Expansion joints are considered necessary to reduce excessive cracking, due to temperature changes. The average temperature range in Jackson County is 128 deg., from —22 deg. to +106 deg. To reduce cracking further (in addition to the marginal ¾-in. rod dowels across the center), ½-in. rods are placed parallel to, and 6 in. from, each joint, with a 4-ft. rod placed diagonally in each corner (Figs. 2 and 3). No cracks have appeared in

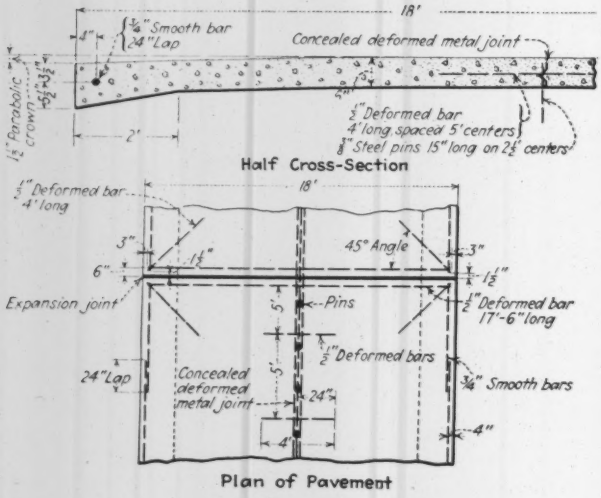


FIG. 2—STRUCTURAL DETAILS OF CONCRETE PAVEMENT

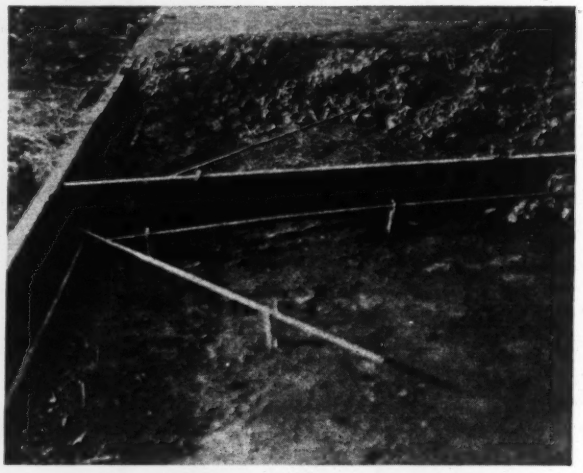


FIG. 3—CORNER AND JOINT REINFORCEMENT FOR CONCRETE PAVEMENT

any slab, except at the planes of weakness, in pavement which has been in use since May, 1929. It was not expected to eliminate all cracks but to reduce the number to a minimum. Experiments are under way to determine the value of the dummy joint, both longitudinal and transverse, to replace the steel joint, the object being to eliminate raveling or spalling due to jagged breaks above the steel joint.

The concrete proportions are 1:2:3½, with materials dry and rodded. All materials are proportioned by weight. The cement factor has averaged 1.49 bbl. per cubic yard of concrete; bulk cement has been used with success on two large contracts.

The haul for mixed concrete is limited to delivery in 30 minutes, but only on two small contracts has concrete been handled from a central mixing plant. The slump averages 1½ in. All joints are submerged so as to form a perfect riding surface. All bumps found by straightedge are removed while the concrete is workable. No bush-hammering is allowed, but rubbing with a carborundum brick to remove small bumps is permissible. The concrete is cured by using calcium chloride on the surface in warm weather, or as a 2 per cent solution in the mix when the temperature runs below 50 deg., or by using an asphalt emulsion. All these methods have been satisfactory. Beam tests determine the date of opening. Traffic is kept off the concrete until the modulus of rupture goes over 550 lb. per sq.in., but in no case is the pavement opened to traffic in less than seven days.

Asphaltic Concrete Roads—Asphaltic concrete, Topeka type, has been placed on an 8-in. reconstructed base, taking full advantage of the existing macadam in place. Such work was done on the base as was deemed necessary to replace or strengthen weak spots. A 6-in. curb, 10 in. deep, was placed on each side. The new base rock was rolled and thoroughly waterbound. Irregularities in the base were taken out with binder. The 2-in. wearing surface was then placed and thoroughly rolled.

The objections to this type of pavement are: (1) uneven surface due to the fact that proper cross-rolling is impossible and to the necessity of following the existing grade; and (2) cost, which is practically equal to that of plain concrete. Because of these facts concrete is more satisfactory and will be used hereafter.

A number of processes for low-cost roads have been

developed; the one used in Jackson County is based on the work done in Indiana under A. H. Hinkle, maintenance engineer of the state highway department. The Jackson County work consists of 30 miles of retread, and is being carried out by the Hayes Construction Co., of Indianapolis, Ind. These roads were originally constructed of quarry-run, crushed limestone, laid to an average depth of 12 in. and about 14 ft. wide. They have been maintained for years by adding stone and treating with road-oil and tar, until a mat has been formed over the entire surface to a depth of ½ to 1½ in.

All culvert work is done first, extending the headwalls where needed. The shoulders are then graded, leaving

FIG. 4—SPREADING CENTER STRIP OF STONE FOR BLADING TO FULL WIDTH

the berms high. Stakes are set for the edge of the base, making use of the old road and widening it where needed. In widening, all material is removed until a good base is exposed, and then boards are set to smooth the outer edge and the trench is filled with 3-in. to 1¼-in. stone. This is penetrated with about 1 gal. per yard of cut-back asphalt. The keystone is then added and the trench thoroughly rolled.

The crown on all these old roads is excessive, running an average of 12 in. The old surface is scarified and thoroughly broken down, mixing the bituminous materials with the base until a test will show not more than 1½ per cent of bitumen at any point. This surface is graded and maintained until the desired section with a 2- to 3-in. crown is obtained. The entire operation is so conducted that the base is not weakened while removing the excessive crown.

In places where the crown cannot be taken out on account of the thin base, stone is added to the sides to bring the roadway to the proper crown. When the surface material of the base is too fine, chips are added. The entire base is then thoroughly rolled. The bitumen in the old mat allows the stone to compact thoroughly. All weak spots that develop are removed and rebuilt. A tar primer is then put on with a distributor at the rate of 0.3 to 0.33 gal. per square yard and is allowed to penetrate well down. This tar is a very light grade, with a viscosity of 8-13, and is applied cold. It is used on account of its moisture-resisting qualities to form a weather-resisting foundation. After 24 hours the base is again thoroughly rolled.

When the base is completed, stone is placed along the outer edge of the pavement, and earth is pulled up with a small grader to form the berm. No boards are used, as they interfere with surface mixing. Stone, 2½ to 1¼ in. in size, is then spread down the middle of the base about 9 ft. wide, deep enough to cover the entire base about 2 in. The manner of spreading the stone is shown in Fig. 4, and the stone is left in this condition to accommodate traffic until ready for treatment.

When ready to pour asphalt, the stone is spread with a 12-ft. grader to within 3 in. of the earth berm on the sides. Then the surface mixer (Fig. 5) goes over the stone three or four times until the section and profile are secured. Stone is hauled by small trucks to take out any thin spots that develop. This operation brings the stone to within 2 in. of the berm on each side. Cut-back asphalt is then applied at the rate of 0.7 gal. per square yard, and the surface mixer is then pulled through to turn the sticky side of the stone down. The roadway surface is immediately rolled with a 10-ton, three-wheeled roller once or twice until the stone begins to chip. After about 5 hours, 0.25 to 0.33 gal. per square yard of cut-back asphalt is applied and rolled, with water on the roller wheels. Mixing has pushed the stone out to the berms, making the roadway full width. Men go along the edge with forks or rakes to true up the side lines. After two days, keystone 1½ to ¼ in. in size is spread on the surface at the rate of 175 to 200 tons per mile.

Open spots are touched up and the surface is dragged with the maintainer until all depressions are filled, leaving a thin layer of chips on the whole surface. The third application of 0.25 gal. of cut-back asphalt per square yard is then added and the surface thoroughly rolled. The berm is rolled with each operation to tie the edges of pavement and shoulder together. After the third application the road is allowed to dry out for five days. Then all surface voids are filled with sand, swept into place with a power broom, all surplus going to the outer edges.

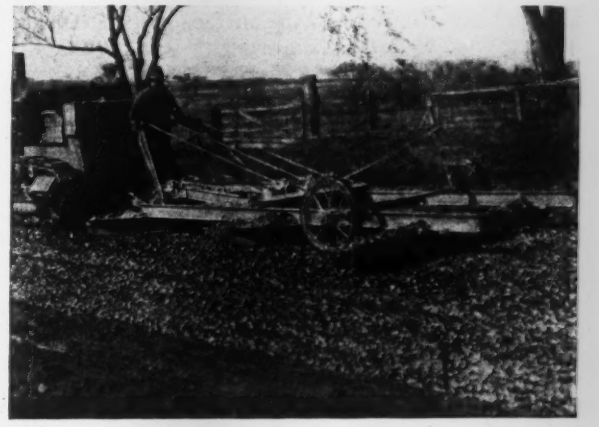


FIG. 5—SPREADING STONE PREPARATORY TO FIRST PENETRATION TREATMENT

The seal coat of emulsified asphalt is then applied with the distributor at the rate of 0.3 to 0.4 gal. per square yard and the surface is immediately covered with ¼ in. of sand and rolled once. The pavement is then swept and maintained for two weeks after completion. Traffic can use it immediately.

The asphalt used is a cut-back, 85-100 penetration base, compounded with a naphtha solvent, which arrives at the point of application with about 30 per cent of solvent in the mixture. The reason for using the cut-back asphalt is to allow the mixing of aggregates in place on the road and the thorough covering of particles. The emulsified asphalt used in the prime coat is made

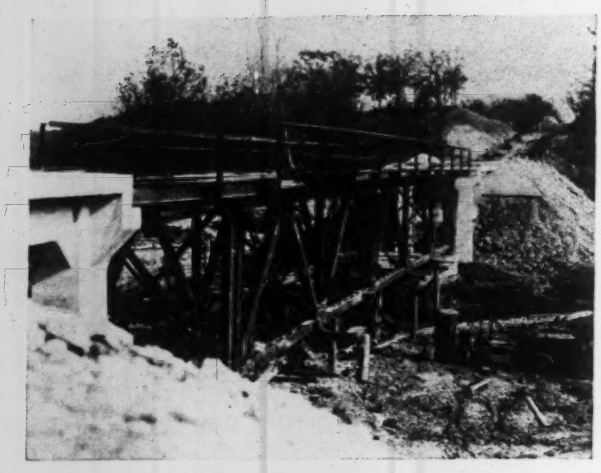


FIG. 6—TYPICAL STEEL BRIDGE ON CONCRETE ABUTMENTS

from a compound of soft asphalt, mixed with about 50 per cent of water. The emulsion will readily penetrate 1 in. of sand and coat each particle.

The riding qualities of these roads are excellent. The surface of the finished roadway is that of sheet asphalt. The base is constructed about 6 in. wider than the top. The shoulders are tied into the surface so that raveling is not expected to develop.

The weak points lie in securing properly graded stone, of the two sizes required, of the proper quality to resist wear, and the necessity of securing some method of definite quantity of asphalt as applied, all to secure a dense mass (the stone keyed and bonded) but without excessive asphalt.

The predominant types of bridges are steel spans (Fig. 6) on tie-back abutments, with a few concrete deck girder spans and one steel-deck span structure. The tie-back abutment is used wherever possible because the solid walls are of great advantage in holding the approach fills. On the longer bridges with approach spans, some type of solid-wall abutment is generally used for the same reasons. Rigid frame abutments were adopted for the approaches to the steel deck span.

The 20-ft. roadway superstructures are standardized and are modeled after the standards of the Missouri State Highway Commission. The wider roadways are of special design. In all bridge design, both of the superstructure and substructure, particular attention has been given to the matter of appearance.

The steel spans are given a final coat of aluminum paint because of its protective and durable qualities, its pleasing appearance and its visibility.

Construction Costs

Costs vary so much with varying conditions that these figures on work in Jackson County are given as a matter of interest only.

Grading: (Class A excavation) earth and loose rock, cu.yd.	$0.30-$0.43
(Class B excavation) ledge rock, cu.yd.	0.83- 1.75
Pavement: Plain concrete, sq.yd.	1.80- 2.00
Asphaltic concrete, Topeka type, sq.yd.	1.07
Retread, sq.yd.	0.60
Concrete masonry in culverts or bridges, cu.yd.	18.00-21.00
Bridges: Steel spans—tie-back abutment, 20-ft. roadway, ft.	145.00
Steel deck span—I-beam approaches, 20-ft. roadway, ft.	110.00
Steel span—concrete girder approaches, 20-ft. roadway, ft.	125.00
Concrete deck girders, 20-ft. roadway, ft.	105.00
Concrete deck girders, 40-ft. roadway, ft.	153.00

Concrete roads have cost $30,000 to $35,000 per mile. The retread roads have cost an average of $10,500 per mile. A point of interest on the later type of construction is that all work is done on a unit basis, that is, the stone is paid for by the ton and the asphalt by the gallon. In this way the quality of the work is kept uniform regardless of conditions uncovered. To date, 150 miles of road are under contract at a cost of $4,200,000. Plans are under way for 74 miles to complete the program, for a total of $6,500,000. Engineering costs have averaged a little less than 5 per cent.

Rolling Aluminum Structural Shapes

Massena Mill Now Turning Out a Range of Sections From Zees to Channels of Strong Alloy From 3,000-Lb. Ingots

COMMERCIAL production of aluminum rolled structural shapes in large sizes, under development at the new Massena mill of the United States Aluminum Co. for some months, has reached the stage of commercial production. Five sections and sizes are already being rolled in various weights, and others will follow soon. The present sections are 10-in. ship channels, 8-in. structural channels, 6x4 and 5x3½ angles, and 4-in. zees. The material is strong alloy, of duralumin type. It presented new metallurgical and mill problems compared with steel, but these have been successfully worked out, as was apparent from inspection of the product two weeks ago during a showing of the new plant in operation.

As described in our issue of Oct. 3, 1929, p. 535, the rolling mill with its alloying and ingot-casting plant was specially designed for shape production. It adjoins an older fabricating plant of the company, where transmission line wire and cable are made, and is supplied from the adjoining main reduction plant where the Aluminum Company of America (of which the U. S. Aluminum Co. is a subsidiary) produces 300,000 lb. of aluminum per day.

The design of the material is based on the following requirements: precise alloying, solidity and absence of segregation in the ingots, close limitation of rolling temperature, large power demand in rolling (more power is required than for rolling steel), and heat treatment

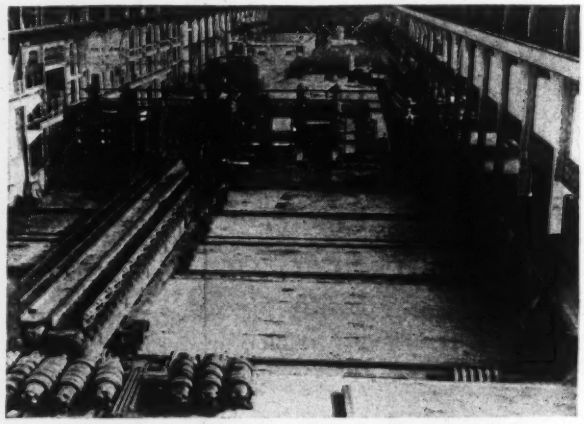


FIG. 1—STRUCTURAL MILL AT MASSENA
Comprises three 26x84-in. three-high stands. Beyond the mill are cutting-off shears, heat-treating furnaces and straighteners.

after rolling. In addition to a blooming mill and a structural mill the plant includes a melting and ingot-casting building at the entering end and a heat-treating furnace and an aging room at the outgoing end. Full pyrometric control governs the melting furnaces, ingot- and bloom-heating furnaces, and heat-treating and aging equipment. Milling machines are provided for removing the defective surfaces of ingots in their preparation for rolling.

Ingot Casting—The 5-lb. aluminum pigs are melted in reverberatory furnaces of 20,000-lb. capacity; here the alloying materials are added (when dural is to be produced; but high-purity aluminum ingots for wire and other products are also cast in the plant). Ingots are cast in two ways, both devised for elimination of segregation: vertically in 12x12x48- to 72-in. ingots weighing up to 1,000 lb., and horizontally in 15x28x72-in. ingots weighing 3,000 lb. The molds are preheated. Vertical ingots are poured in heated pits through a 2-in. pipe

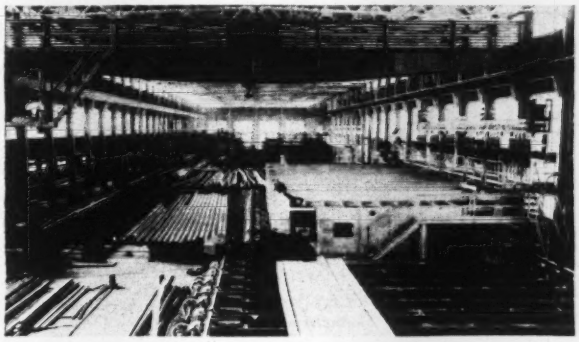


FIG. 2—FINISHED SHAPES FROM MILL TABLE (LEFT) GO TO TREATING TABLE (RIGHT)
The crane which serves the structural mill is built of duralumin plates and angles.

extending down to the bottom of the mold and receiving the melted alloy from a skimming basin into which the ladle pours. Immediately after the pouring, a ring of water sprays chills the bottom of the mold and travels upward at the rate of 1 in. per minute, while the top of the ingot is kept hot by flame blast. This rapid chilling in layers prevents segregation while the metal solidifies and provides for down-feeding of melted material to fill the pipe that otherwise would form. Similar chilling is applied to the horizontally cast ingots, which are poured from a skimming spout fed direct by the tap-hole of the furnace and are then pushed back into the preheated chilling furnace. Control of segregation is less complete in this method, and vertical casting may later be adopted for the large ingots in spite of the greater handling difficulties.

Rolling—After cooling and inspection, the ingots are scalped in milling machines on their upper face (wire ingots on all four sides), and then go to electric heating furnaces supplied with 2,000-kw. heating capacity, operating under automatic control checked by recording pyrometers, where temperature is controlled to 10 deg. F. The rolling temperature is 900 deg. F., with an available range of 75 deg. below this; at higher and lower temperatures there are rolling difficulties.

Breaking down the ingots for the structural mill is done in a reversing blooming mill whose rolls are 38x84 in. It is driven by a 5,000-hp. direct-current motor which runs at 520 r.p.m. maximum speed and whose shaft carries a plate flywheel 16 ft. in diameter, weighing 70,000 lb., to absorb load fluctuations. The motor is supplied by a motor-generator set fed by 6,600-volt alternating current from the incoming transmission line.

A shear crops the blooms and cuts them to length; they then go on narrow-gage cars to the adjoining structural mill. Here a conveyor furnace fired by oil brings them to rolling temperature and feeds them to the rolls which supply the mill. The mill is three-high, with tilting tables, and comprises three stands of 26x60-in. rolls and a final two-high stand 26x48. The outgoing roller table takes the finished shapes to a friction hot-saw, where they are cropped; beyond the saw they are traversed on hotbeds to the feed end of the heat-treating furnace.

Electric heating is used also in this furnace. Lengths of 90 ft. can be accommodated. The working area is divided into 26 heating zones separately controlled by automatic regulators set to maintain constant temperature. Pieces remain in this furnace one hour, and then, on passing out, go through water sprays which quench them. Beyond this point is a straightening press and saws for cutting the pieces to ordered lengths.

For such alloys as require aging, a steam-heated aging oven is provided at the outgoing end, which also is long enough to take 90-ft. pieces.

Aluminum Traveling Crane—Aside from the rolling equipment itself, the structural mill is interesting because it is served by an overhead crane built of aluminum alloy. It has a 72-ft. span and a lifting capacity of 10 tons. A precise duplicate, but of steel, is in the blooming-mill building. The aluminum crane weighs 24,000 lb. less, and therefore has better speed and pick-up and consumes less power. Its service is expected to give practical demonstration of the utility of aluminum alloy in structural service.

Utilization—Large structural shapes in the strong aluminum alloys have been demanded for some time, especially for use in transportation services, where less dead weight means greater pay loads. Duralumin members have been built into electric railway cars, trackless trolleys, railroad coaches, freight cars, trucks and buses, but the engineering possibilities of the material remained restricted by the small size of the structural shapes available. With the advent of the larger rolled shapes this limitation is removed. Moving machines, the upper parts of tall buildings, and long-span bridges, where weight reduction is important, are other fields which permit of deriving economies through the fact that aluminum weighs only one-third as much as steel.

Because of the resistance of aluminum to corrosion, moreover, these structural shapes find valuable application in chemical plants and trainsheds, or wherever corrosive fumes are present.

Nail-Pickers Effective on New Mexico Highways

Nails and scrap iron amounting to 131,194 lb. were removed from the New Mexico highway system during 1929 by five magnetic nail-picking trucks, operated as a part of the state highway maintenance equipment. The machines operated during the entire year, covering 29,113 miles, representing more than five trips over the highway system. The weight of metal removed averaged approximately 4.5 lb. per mile for all types of highways and the cost of the work was about $10,000.

Plan Second Highway Tunnel Under Hudson River

State Officials of New Jersey and New York Meet to Consider Projects of Tunnel Commission and Port Authority

SINCE New York City decided, some months ago, to build a crosstown highway tunnel in the vicinity of 38th St. extending eastward under the East River to Queens, much sentiment developed in New Jersey and New York for a Hudson River tunnel to connect with the crosstown tunnel and provide a new through route to New Jersey. Interest of the state authorities grew to the point of arranging a joint meeting last week of the governors and committees of the legislatures of the two states to discuss the undertaking and inspect plans. The existing two interstate agencies, the Port of New York Authority and the Interstate Joint Tunnel Commissions, submitted plans by invitation, both bodies having for some time looked forward to the construction of additional river crossings and having advanced rival claims for control of their construction.

The Tunnel Commissions form the body which designed and built the Holland tunnel and now manages its operation; the Port Authority, organized by treaty between the two states to develop more efficient freight handling in the port of New York, has built no tunnels but (under special legislative direction) built two bridges across Arthur Kill and now is building the Fort Washington-Fort Lee bridge across the Hudson River and the Bayonne bridge across Kill van Kull. Not only the functions and background of the two bodies but also their form of organization and financing are fundamentally different. While the financial estimates for the midtown tunnel are affected by these differences, both estimates contemplate using the revenues of the Holland tunnel to assist in the financing.

Traffic—Growth of cross-river traffic since opening of the Holland tunnel has been far beyond advance calculations. Using the Holland tunnel data and corresponding estimates of traffic for the Hudson River bridge (after 1932, its scheduled opening), future traffic is estimated to provide nearly capacity load for the midtown tunnel in a few years (Fig. 3). Even with the new bridge and tunnel, a ferry load about equal to that now existing would continue. The midtown tunnel traffic, however, would carry and soon pay for the tunnel, at toll rates equal to those of the Holland tunnel (average 55c. per vehicle). The capacity of either tunnel is taken at 15,000,000 vehicles per year in the Tunnel Commission estimate and at 17,500,000 vehicles in the Port Authority estimate.

Location and Type—Both plans, shown in location and profile in the map, Fig. 1, place the eastern terminus in the vicinity of West 38th St., Manhattan Borough, New York City, cross the river about at right angles, and end near Homestead, on the west face of Bergen Hill, along the east edge of the Hackensack meadows. They provide two two-lane tubes, which in the underwater portion are concrete-lined cast-iron shield tunnels. The river sections are substantially alike, being located with invert about 90 ft. below high water between pierhead lines, as the War Department requires a clearance of 55 ft. and sufficient cover for protection is desired. The shore portions differ markedly.

On the New Jersey side the Port Authority project continues in a straight line and remains in tunnel to the meadows portal, while the commission project deflects southward around a nose in the east face of Bergen Hill

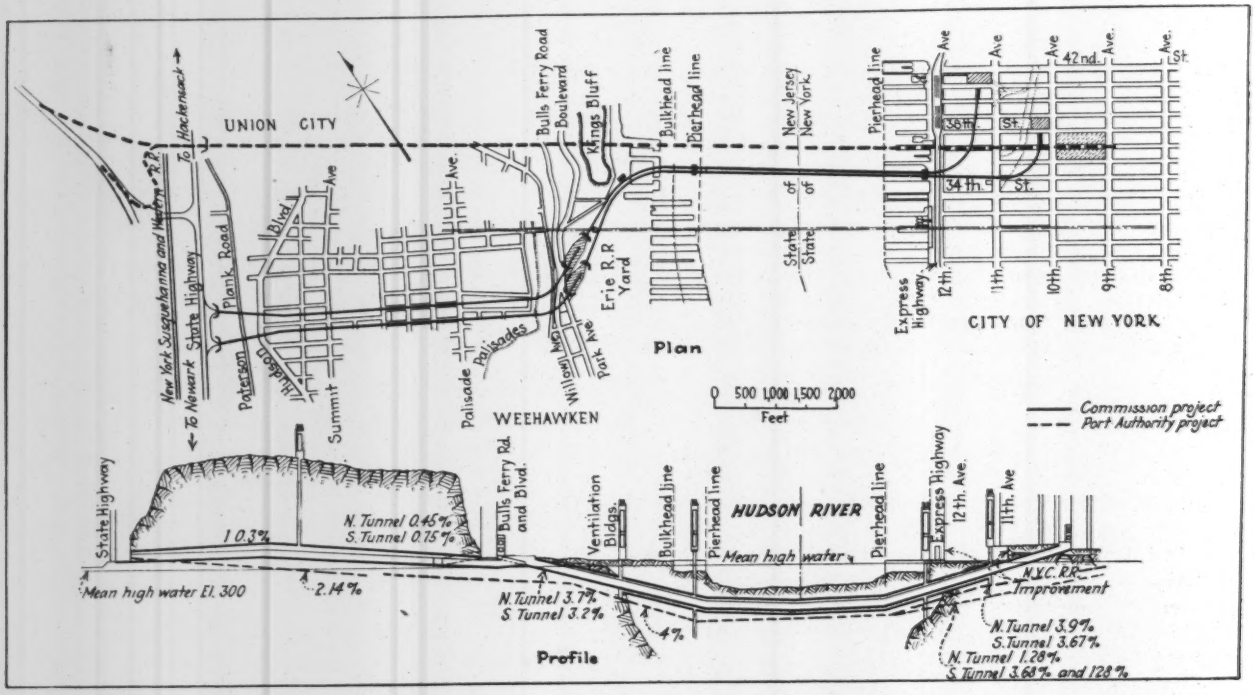


FIG. 1—TWO PLANS FOR HUDSON RIVER MIDTOWN TUNNEL

Interstate Tunnel Commission location shown by full lines, Port Authority location by dash lines. The former traverses Bergen Hill at high level and emerges on the east face of the hill at an open-air junction plaza for riverside traffic. The Port Authority plan descends continuously from the meadows portal to the river. The plans also differ materially in type and location of New York terminal. Both contemplate two separate tunnels of two lanes each.

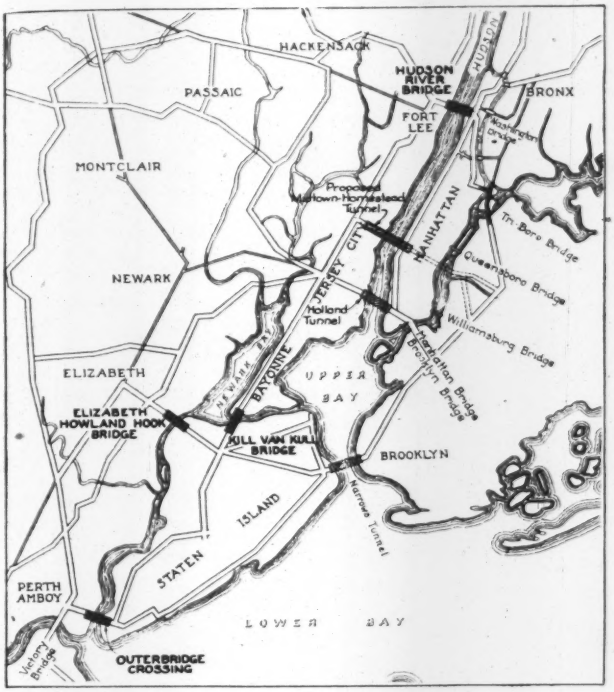


FIG. 2—INTERSTATE CONNECTIONS AT NEW YORK
Ferry lines are not shown.

(the Palisades) and at this point reaches the surface to form an open-air plaza where riverside traffic can connect.

On the New York side the Port Authority project extends easterly to a large underground plaza east of Tenth Ave., where traffic connects with the city streets or with the crosstown tunnel, which under this plan would reach the same plaza. The commission project, on the other hand, remains west of Tenth Ave., and swings both tubes northward to separate terminal plazas, one at 39th St. and Tenth Ave., the other at 42nd St. and Eleventh Ave. This arrangement contemplates full separation of inbound and outbound traffic by assigning them separate avenues. For this purpose only Eleventh and Tenth Aves. are available, as Ninth Ave. is occupied by an elevated railway and Eighth Ave. is a busy commercial street which forms one of the main north-south routes for intracity traffic. The terminal location also affords convenient access to the elevated express highway now being built by the city along Twelfth Ave.

Connection of the Hudson River tunnel with the crosstown tunnel is made in the joint plaza in the Port Authority project. The commission project provides for a surface connection of the eastbound tunnels and a viaduct connection of the westbound tunnels, eliminating street crossings but permitting the traffic of the two tunnels to reach the streets separately and distribute in all directions (Fig. 4).

One of the drawings (Fig. 5) shows the type of construction contemplated in the commission project. This project has a considerable part of its Manhattan portion in open-cut work (above tide level), while the Port Authority project remains at greater depth and includes more rock tunnel. Large differences of class of work occur also on the New Jersey side, due to location and profile.

Cost and Time, Commission Project—The commission project is estimated to cost $66,928,000 excluding the cost of the connection with the crosstown tunnel and excluding interest during construction; these items represent three millions and seven millions respectively, making the inclusive cost about $77,000,000. Main items are tabulated below. The estimates are based on rates of progress and working experience in the Holland tunnel but take account of present-day labor and material costs (all classes of labor and some materials are higher at present).

Assuming immediate beginning on working preliminaries, and first contracts let July 1, 1931, the commission estimates that the tunnel could be opened on or before July 1, 1936. Traffic is estimated at ten million vehicles the first year, increasing to fifteen million in 1940; net income (after all operating costs) would be $3,200,000 the first year and $7,000,000 in 1940. As the Holland tunnel (earning net $4,636,776 in 1929, $7,250,000 in 1932 and thereafter) will have refunded its entire cost by 1937, its revenue thereafter can be applied to refunding the midtown tunnel cost. On this basis the cost of the tunnel can be retired by Oct. 1, 1943, a little more than seven years after opening.

ESTIMATED COST, COMMISSION PROJECT

River tunnels	$20,923,000
Bergen Hill tunnels	11,822,000
Open cut and subway	8,381,000
Plazas	392,000
Paving and finish	1,809,000
Ventilation and drainage	5,718,000
Terminal buildings and equipment	825,000
Real estate	7,620,000
Engineering, administration and borings	4,438,000
Contingencies	5,000,000
Total	$66,928,000
Half cost of connections to crosstown tunnel, about (city to pay other half)	3,000,000
Interest during construction (at 4½%)	7,400,000

In a memorandum on the project Ole Singstad, chief engineer of the commission, concludes from this remarkable financial result as follows:

> The proposed tunnel will be the third fixed crossing for vehicles of the Hudson River between New Jersey and Manhattan. It is already apparent that many more of these highway crossings will be necessary within a few years.
>
> I believe that the program cannot be considered complete until a total of seven such crossings have been provided between the Battery and Spuyten Duyvil. These crossings may all be required within the next 25 years and must be located so as to fit into the

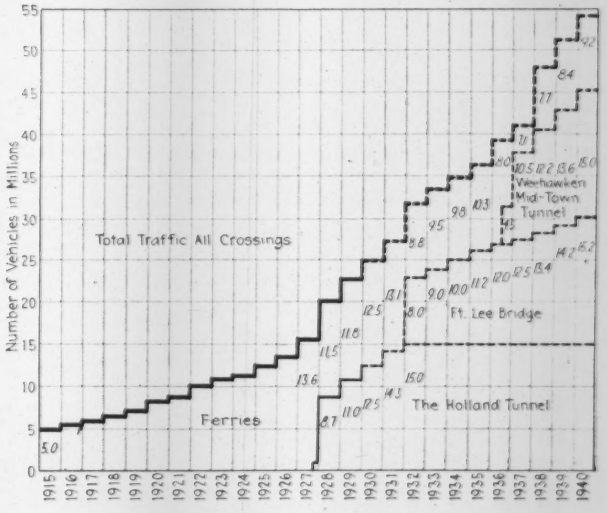


FIG. 3—EXPECTED CROSS-RIVER TRAFFIC
Commission estimate; Port Authority estimate similar.

highway systems of the two states and at points where traffic relief is most needed.

The Holland tunnel will be fully paid for by about the time the Weehawken-midtown tunnel is opened, and the cost of the second tunnel will be repaid in a much shorter time than the Holland tunnel as the net earnings from both tunnels can be used for that purpose.

The third tunnel can be financed out of the net earnings of the first two tunnels without additional financial aid.

Similarly, succeeding tunnels can be financed from the earnings of the previously constructed tunnels.

For financing the work the commission proposes a loan of $13,500,000 by New York State, use of New York's unappropriated net income from the Holland tunnel, and a New Jersey bond issue of about thirty-three millions.

The bond interest during construction would be paid from state funds as was done for the Holland tunnel bonds. Immediately after completion the net revenues of both tunnels would be applied to retirement of all these advances and everything would be paid up in 1943.

The above figures do not include allowance for the cost of the crosstown tunnel connection.

Cost and Time, Port Authority Project—Total cost of the Port Authority tunnel project is estimated at $95,500,000, including interest during construction. Part of the excess over the commission estimate is due to the location, which includes more rock excavation. Another item of increase is five millions for bond discount, and

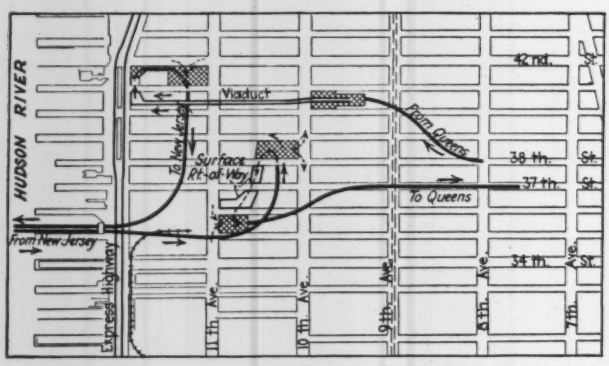


FIG. 4—COMMISSION'S PLAN FOR CONNECTION OF PROPOSED TUNNEL WITH CROSSTOWN TUNNEL

nearly a million for development of personnel and operating capital.

Time of completion is estimated approximately as in the commission project.

The Port Authority's financial plan for the work contemplates utilization of the Holland tunnel net revenue, and issuance of Port Authority income bonds for the remainder. With 4½ per cent coupon rate, these bonds are expected to bring 95.

ESTIMATED COST, PORT AUTHORITY PROJECT

(a) Construction and equipment (tunnel proper)		$61,000,000
Manhattan approaches, Ninth to Eleventh Ave.	$8,546,500	
Hudson River tunnels, face of Palisades, New Jersey to Eleventh Ave., Manhattan	29,541,900	
Approach tunnels through Bergen Hill from face of Palisades in Weehawken to Paterson plankroad in Homestead	12,623,900	
Weehawken highway connections	2,646,490	
Homestead highway connections to State Routes No. 1 and No. 3	1,384,650	
Unallocated items and equipment	6,050,000	
Total construction items	$60,793,440	
(b) Engineering, administration and contingencies		9,760,000
(c) Real estate		8,650,000
(d) Interest during construction		10,230,000
(e) Cost of financing and development reserve		5,860,000
Total		$95,500,000

The project also contemplates that the four Port Authority bridges, the Holland tunnel and the midtown tunnel shall be consolidated. J. E. Ramsey, executive officer of the Port Authority, states in his project report:

Future interstate crossings, if and when determined to be economically practicable, may be provided through the utilization of the credit of the Port Authority.

The plan should provide that the tolls charged for the use of these facilities, whether bridges or tunnels, should revolve through a general fund.

The problem of better interstate communication, regardless of whether it is to be solved in part by improved all-rail facilities and in part by vehicular connections, is *one* problem, and these

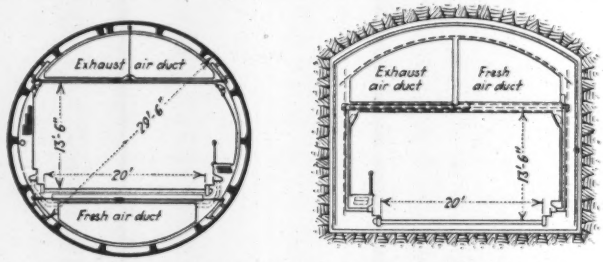


FIG. 5—CROSS-SECTIONS OF COMMISSION TUNNEL

facilities should not be considered and dealt with separately or as individual projects, but as one general comprehensive plan.

Two investment banking companies . . . point out that two circumstances will make these proposed bonds less attractive than prior Port Authority issues: first, the states will not advance any sums in aid of construction; and second, the fact that the Holland tunnel is operated by state agencies not connected with the Port Authority will have an unfavorable effect upon the 38th St. tunnel issue inasmuch as investors in Hudson River bridge issues have frequently inquired into the possibility of the Holland tunnel tolls being reduced or the tunnel being made toll free, and the possible effect of such action upon Hudson River bridge revenues.

Cost of Yard-Dipping Pipe

Installation of a gas system in Merrill, Wis., in which every foot of pipe laid in the town was coated in a yard by the dipping method yielded the following cost figures, which are quoted from *Bits O' Mastic*, the house organ of the Wailes Dove-Hermiston Corporation, New York:

	Cost Per Ft. 2 In.	3 In.	4 In.
Material, including solution, enamel, thinner, daubers, brushes and fuel for heating	$0.0179	$0.0273	$0.0324
Labor, including handling, painting, enameling, digging bell holes under joints and daubing all joints in the ditch	0.0087	0.0128	0.0172
	$0.0266	$0.0401	$0.0496
Cleaning, including labor, gasoline, rags and brushes	0.0033	0.0036	0.0039
Total	$0.0299	$0.0437	$0.0535

Street mains were of 4-, 3- and 2-in. pipe, and ¾-in. service lines were laid from the mains to buildings. In the yard three dipping tanks were set up in a line so that operations were continuous. These contained solution, enamel and whitewash, which was originally intended to be used only during hot weather to protect the enamel against sagging. However, it was found advantageous to use the whitewash dip at all times, as it caused the enamel to set quickly and prevented sticking to the skids.

An unusual method of lifting and handling the pipe worked out very satisfactorily on this job. For each size of pipe, sockets about 6 in. long were made out of pipe of the next larger size. One end was closed, and to it was welded a handle resembling an automobile crank handle. This socket could be slipped on the end of the pipe to be treated, combining the functions of lifting the pipe, covering the ends and protecting the threads.

News of the Week

Mexico Selects Final Route of Pan-American Highway

Definite location of the Mexican section of the Pan-American Highway has been made by the Mexican government. Within this country, the highway will have a length of approximately 1,600 miles. It will unite nine states and the federal district, starting on the north at Laredo and proceeding through Mexico City to Suchiate, on the frontier of Guatemala. Cities of importance on the route include Monterrey, Ciudad Victoria, Pachuca, Puebla, Oaxaca, Tehuantepec, Tuxtla and Tapachula. Up to the present time approximately $7,500,000 has been spent on this highway, about half of which is now in good condition for travel. About $2,750,000 will be spent during 1930 on the section from Mexico City to Laredo, which should be finished by 1931.

Railway Construction Contracts to Be Awarded

Within three weeks the Northern Pacific Railway expects to call for bids for building a new line from Moclips, on the western coast of Washington, northward to the Hoh River. Actual construction work is scheduled to start April 1 under P. E. Thien, construction engineer. Two contracts are to be awarded, one for four reinforced-concrete bridges to span the Queets, Clearwater, Quinault and Hoh rivers; the other to cover clearing, grading, tracklaying and small bridge work. The bridges across the Queets and Quinault rivers will be 3,000 ft. in length, the Clearwater bridge will be 1,300 ft., and the Hoh bridge 1,000 ft.

Site Selected for Vicksburg Hydraulic Laboratory

Suitable land for the proposed hydraulic laboratory of the Mississippi River Commission has been found near Vicksburg, Miss., and authority for its purchase has been requested. Plans for the laboratory include the construction of an earth dam which will form a 40-acre reservoir with a capacity of 200 acre-ft. This will give a flow of 40 sec.-ft. for research work. A brick building 50x215 ft. will house the offices, workshops and laboratory working space. Outside the building adequate space will be available for the construction of outdoor models. The commission will continue its policy of making hydraulic studies and investigations on the ground in question, but will supplement such studies by work at the laboratory.

Floods in Southern France Cause Losses to Life and Property

About 300 Deaths and Much Damage to Towns Reported—Deforestation Blamed for High Water

Engineering News-Record Cable Report

SEVERE floods in the Garonne-Tarn Valley of southern France during the past week were due to heavy, but not extraordinary, local rains. Combined with this, however, were exceptionally high temperatures for this time of year, causing precipitous snow meltage in the midland plateau. The possibility of just such a disaster has been foreseen ever since the almost complete deforestation of the area during the World War, since which there has been almost no material extension of earth dikes, heretofore more or less controlling perennial secondary floods in the region. Correctives, particularly reforestation, have been discussed but have not been executed.

The custom in this part of France of locating villages on high ground averted a much greater catastrophe, but mill and industrial towns, notably the woolen mill and hydro-electric centers of Castres, Albi, Montauban, Villemur and Moissac, have suffered heavy damage. The flood area is about 60 miles square, including nine departments. The greatest intensity of devastation was at the confluence of the Tarn, Agout and Aveyron rivers, draining the Massif Central and the Black Mountains.

The crest of the flood was reached at night, with a maximum of 70 ft. above normal in the Narrows, elsewhere roof high, thence diminishing with ample forewarning to inhabitants down the Garonne-Gironde through Bordeaux, where it met coincident storm tide, flooding several suburbs. There was a lesser flood at Carcassonne, on the Aude River, flowing from the same mountainous region toward the Mediterranean.

Damages in the flooded area are still untabulated. Deaths, largely due to the skeptical reluctance of the population to leave their homes when warned, are expected to total 300. Thorough anti-epidemic measures are being taken by health officials to prevent the spread of disease due to exposed graveyards and unburied livestock corpses. The region is agricultural, most important crops being vins ordinaires, sheep, cattle and corn, in relative order of importance. While losses are material, they are only local and irrelevant to general French prosperity, whereas reconstruction requirements will be a stimulus to industry. Local impoverishment is partly offset by relief measures, including passage of a relief bill of $20,000,000 providing long term credit at low rates. The greatest loss probably is in the vineyards, which require a minimum of four years growth before they produce.

I. S. Holbrook Dies

Isaac Standish Holbrook, advertising representative in the metropolitain district of New York for *Engineering News-Record* and *Construction Methods*, died March 7 at Miami, Fla., at the age of 53. He had gone to that city earlier in the winter to recuperate from illness. One of the pioneer and widely known figures in the field of engineering and industrial journalism, Mr. Holbrook started his career in that branch of publishing with the old *Cassier's Magazine*. He later associated himself with *Engineering Record* and was Eastern advertising manager of that publication when it and *Engineering News* were merged as *Engineering News- Record* in 1917. He enjoyed an exceptionally wide acquaintance among business interests in the civil engineering field. Mr. Holbrook was born in New York City on April 6, 1876, and, at the time of his death resided in Larchmont, N. Y.

I. S. HOLBROOK

Donora Rail Line Contested

The Pennsylvania Railroad will file suit to enjoin construction by the Pittsburgh & West Virginia Railway of a 6-mile branch line connecting the Connellsville extension of the Pittsburgh & West Virginia with the Donora Southern Railroad in the Donora industrial district along the Monongahela River. Construction was authorized by the Interstate Commerce Commission Feb. 7. Advised by the Pennsylvania of its intention to contest the case, the commission has extended the effective date of its order to March 24. The Pennsylvania opposed the project in the initial stage of the proceeding before the commission, claiming that the object of the Taplin line is to take from it the business of the American Steel & Wire Co. The Pennsylvania contended that the facilities of its Monongahela line are adequate for present and potential traffic in this district, explaining that its business has not increased in recent years because of competition from barge lines on the river.

Chicago Citizens Successful in Raising Tax Fund

A citizens committee in Chicago last week completed the raising of a fund of $75,000,000 with which to purchase tax anticipation warrants of the various local governments and permit the payment of overdue payrolls and interest obligations. Philip R. Clarke, president, Central Trust Company of Illinois, headed the drive for the taxpayers' trust. The money will last until July, when 1928 taxes are expected to be paid in. These taxes are being held up pending completion of a reassessment.

Controversy has arisen between officials of the city and the citizens committee over which year's warrants shall be purchased. The city purchased certain 1928 and 1929 warrants with traction funds saved up for many years in a separate account to build subways. The citizens committee wants to buy these 1928 and 1929 warants rather than 1930 warrants so as to shorten the time when the taxpayers' trust may be liquidated and also because the legality of the 1930 warrants has not been entirely satisfactory to the law firms which pass on bonds and other financial paper. The city wants the traction fund replenished so that it will be in a position to start subway construction before the 1930 warrants are likely to be redeemed.

S.P.E.E. Plans Two Meetings for Engineering Teachers

For the purpose of improving methods of instruction, the Society for the Promotion of Engineering Education will this year continue its summer sessions for engineering teachers. Two sections are scheduled: one, at the Carnegie Institute of Technology, on the teaching of engineering drawing and descriptive geometry, and the other, at Yale University, on the teaching of civil engineering. These sessions will be sponsored by the American Society of Civil Engineers, the Highway Education Board and the Portland Cement Association.

The program of the session on civil engineering, to be held at Yale University from July 1 to 23, is arranged in two parts, one for all of the teachers in attendance, the other in parallel divisions relating to structural engineering, sanitary and hydraulic engineering and highway and railway engineering respectively. Subjects covered in the general division include engineering materials, engineering economics, the history of civil engineering, the ethics of professional practice, the business aspect of civil engineering, relationship of teachers to students, and a number of other topics. The divisional meetings, to be held simultaneously, will deal more specifically with the problems of teaching particular subjects. This session will be conducted under the immediate direction of John C. Tracey, professor of civil engineering at Yale University, and Prof. R. H. Suttie, of the same institution. Francis T. Spaulding, of the Graduate School of Education, Harvard University, is educational adviser. The entire teaching staff comprises 45 teachers and practicing engineers, including such well-known authorities as F. E. Turneaure, Anson Marston, C. C. Williams, T. R. Agg, C. M. Spofford, and, among the practicing engineers listed, F. P. McKibben, J. A. L. Waddell, O. E. Hovey, Samuel Eckels, Thaddeus Merriman, F. R. MacMillan, W. P. Creager and O. H. Hammond.

Carnegie Institute of Technology, Pittsburgh, will be the scene of the session on drawing and descriptive geometry, which will extend from June 12 to June 23 inclusive. This session will be in charge of William E. Mott and H. M. McCully, both of Carnegie Institute of Technology, and Thomas E. French, of Ohio State University.

Three Water Districts Proposed for New Jersey

New Commission Sets Up Principles for Future Development and Presents Plan for Northern Section

THREE water-supply districts, a $7,000,000 revolving fund with which the state would acquire reservoir sites and water rights for sale to the districts, and tentative plans for a high-level supply for the North Metropolitan District are the principal recommendations made by the New Jersey State Water Policy Commission in Special Report No. 1, submitted to the legislature on March 4. Fundamental principles laid down in the report are: joint ownership and pooling of all major sources of supply for each district, with interconnections of the various sources and pressure zones where the topography of the areas served demands; divorcing of ownership of the joint sources from distribution systems, the latter to be under municipal ownership, and sale of water at cost to the several municipalities by the central agency, with resale by each municipality "to its own inhabitants at rates consistent with good business and municipal practice." As constitutional limitations are held to prevent state financing of the water districts, some other scheme must be devised, possibly through "an outgrowth of the regional plan suggestion" now under consideration in New Jersey.

The Northern Metropolitan District would take in the area north of the Raritan River and east of the Passaic River, extending to the New York State line on the north and including all of Essex, Hudson, Union and Bergen counties and parts of Passaic, Somerset and Middlesex counties. Among the cities included, from south to north, are New Brunswick, Elizabeth, Newark, Jersey City, Hoboken, the Oranges, Paterson and many smaller places, including the 50 towns supplied by the Hackensack Water Co. The Southern Metropolitan District comprises Trenton, Camden and adjacent towns near Philadelphia. The Seaside Resort District extends from Sandy Hook on the north to Cape May on the south, including Asbury Park, Long Branch and Atlantic City.

The only specific suggestion for supplying the southern and seashore districts is to bring forward again the question of state purchase of the Wharton tract of 156 square miles, now in one ownership, in Ocean, Burlington and Atlantic counties. Purchase of this area, the commission states, would be justified on four grounds: (1) a potential water supply of 240,000,000 gal. daily (240 m.g.d.); (2) reforestation; (3) state park and recreation area; (4) fish and game preserve. Purchase of this tract was voted down by a large majority in a referendum some years ago.

For the Northern Metropolitan District the commission proposes an ultimate division of the territory into four zones, special high, high, intermediate and low levels. For the high-level zone a storage project in the Raritan and Musconetcong drainage area is proposed, with head sufficient to deliver water by gravity between El. 230 and 400. To the relatively small population above El. 400 water would be pumped. For the present, existing supplies would serve the intermediate and low-level zones. Immediate development of the high-level supply is advised, a choice to be made, after further studies, from three different single storage reservoir possibilities — Buddvale, Vernoy and Ralston. From any of these reservoirs an aqueduct would deliver water to filtration works (which might not need to be built immediately) and an equalizing reservoir, both near Summit. This high-level project is intended to supplant both the Long Hill and the Chimney Rock projects, the first recommended in 1922 by Allen Hazen in a report to the New Jersey Board of Conservation and Development and the second proposed in 1925 by Arthur H. Pratt and Morris Sherrerd, then engineer and consulting engineer, North Jersey District Water Supply Commission.

The proposed Northern Metropolitan District is now served by 34 water-supply systems, of which twenty are municipally owned, eleven are owned by private water companies, two by institutions and one by a radio association. Each of these systems furnishes water to from one to fifty cities and towns. Four of them supplied 76.3 per cent of the 275.43 m.g.d. delivered by the 34 in 1928, Jersey City leading with 64 m.g.d., or 23.3 per cent, the Passaic Consolidated Water Co. being a close second, Newark a close third and the Hackensack Water Co. coming fourth, with 30.51 m.g.d., or 11 per cent of the total. The estimated possible safe yield of the 34 systems, after further development of present sources, is 375.2 m.g.d., but

to this 100 m.g.d. will be added in April by the Wanaque project of the existing North Jersey District, and 20 m.g.d., later this year, from the Raritan-Millstone project of the Elizabeth Water Co. These additions raise the total already given to 495.2 m.g.d.

The safe yields of the proposed new high-level supply are 178, 162 and 147 m.g.d. for the Buddvale, Vernoy and Ralston sites; the corresponding draft lines are 480, 500 and 442 ft.; the delivery elevation is 405 ft. in each case, and the distances from the center of the district are 43, 43 and 29 miles. The Chimney Rock project of 1925 has a safe yield of 158 m.g.d., draft-line and delivery elevations of 241 and 200 ft., and is 28 miles from the district center. Total and unit costs of the four projects (including the earlier Chimney Rock project) are: Buddvale, $48,280,000 and $260,000, the latter per million gallons daily safe yield; Vernoy, $42,120,000 and $260,000; Ralston, $45,570,000 and $310,000; Chimney Rock, $48,980,000 and $310,000. It is assumed that after the proposed high-level supply is provided the existing low-level supply would be supplemented, and that the combined total of 250 to 300 m.g.d. from these additions would carry the district "until perhaps 1960" after allowing for the probable abandonment or placing in reserve of some of the now existing sources of supply, particularly that of the Little Falls plant of the Passaic Consolidated Water Co., which produced nearly 59 m.g.d. in 1928 and is assumed to have a safe yield capacity of 65 m.g.d.

The New Jersey State Water Supply Commission superseded the water-supply division of the Board of Conservation and Development early in July, 1929, with Morris Sherrerd as consulting engineer.

The Business Outlook

With February automobile production estimated to be but slightly more than 300,000 cars and trucks, it is evident that the upward spurt, normal for early spring, has not started. Leaders of the industry are fulfilling their promise to produce cars only as customers demand them. For the second consecutive week raw steel production and steel mill activity showed a slight decline from an average of around 80 per cent capacity to 79 per cent. A year ago the industry was operating at 93 per cent with rapidly increasing activity from week to week.

—The Business Week, March 12.

Los Angeles Airport Dedicated

Dedication of the Los Angeles (Calif.) Eastside Airport, owned and operated by Whittier Airways Co., was held March 1. This new airport, located 10 miles east of Los Angeles, is equipped for night flying operations and has a completely surfaced runway system. There are no obstructions or high-tension wires near the field and the freedom of this vicinity from fog makes it an excellent field for all-around operations. Ample hangar space is available for private fliers or commercial operations, and field facilities include a large administration building and depot. The runway system consists of a main runway 3,500 ft. long in a north-south direction and two parallel runways 2,500 ft. long in a southwest-northeast direction. Prevailing winds are from the south. Night lighting equipment includes boundary lights, floodlights, a 10,000-cp. revolving beacon and a ceiling light. Free auto taxi service to Los Angeles or other near-by cities is furnished by the field management. Excellent drainage facilities and ample oil surfacing make the field available for operations in any season.

Honor New Orleans City Engineer

Completion of one of the most important municipal improvements in the history of New Orleans—the rebuilding of Canal St.—was celebrated in that city Feb. 24. Features of this work, which was begun in November and pushed to rapid completion, are two new 35-ft. roadways of sheet asphalt, a new lighting system and sidewalks and a central "neutral zone" 58½ ft. wide paved with terrazzo. The roadway has a total width of 170½ ft. and extends for a distance of fifteen blocks through the heart of the city's business section. For the greater portion of its length it contains four street-car tracks resting on an unusual foundation consisting of flexible diaphragms in place of cross-ties. In appreciation of "the splendid record of achievement in municipal progress attained during the incumbency of the Honorable Bryson Vallas as city engineer, culminating in the realization of greater Canal St., and being desirous of expressing in tangible and concrete form their esteem of him as a man, engineer and aggressive thinking citizen," the Canal Street Improvement Committee has presented Mr. Vallas with an engraved silver scroll, commemorating his part in the undertaking.

Stono Bridge Completed

The Stono River bridge, connecting Charleston, S. C., with St. John Island, has been completed and will be opened to traffic as soon as the approach causeway is finished, which should be in about 30 days. The bridge is 1,850 ft. long, built of creosoted timber with a steel drawspan. The approaches, 1.25 miles in length, consist of two bridge spans, 60 and 110 ft. in length, and a causeway.

Pend Oreille Power Assigned

Control of Pend Oreille water power has been conditionally handed over to the West Kootenay Power & Light Co., Rossland, B. C., by the British Columbia provincial government. The company will be given an opportunity to develop the Pend Oreille to its ultimate capacity, provided it supplies the Reeves-McDonald Mining Co. with power for its mineral developments at fixed rates. These rates will be the same which the Consolidated Mining & Smelting Co. pays the East Kootenay Power Co. for power to operate the Sullivan mines at Kimberley. If the

ERECTING STEEL FOR NEW YORK ELEVATED HIGHWAY

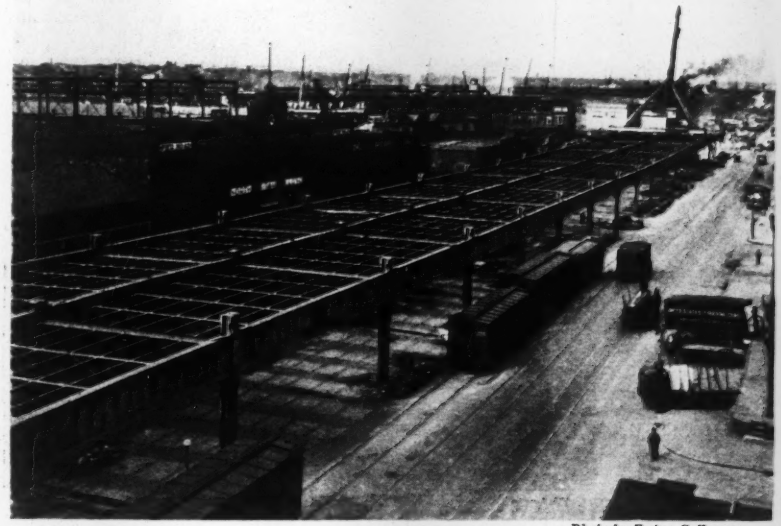


Photo by Ewing Galloway.

Traffic congestion in downtown New York will be partly relieved upon the completion of this 4½-mile elevated express highway which will link lower Manhattan to Riverside Drive at 72nd St. The project, which will cost approximately $16,000,000, will provide two 30-ft. roadways.

Reeves-McDonald company proceeds to build a refining plant at its mines near the Pend Oreille, the West Kootenay company must give it power for this plant at the same rate at which it supplies its parent company, the Consolidated Mining & Smelting Co., for its Trail smelter. On these conditions the Reeves-McDonald application to develop power on its own account on the Pend Oreille has been rejected at this time.

The West Kootenay company has formally agreed to these terms and has until August to file plans for the Pend Oreille project. When they are filed the government can either accept or reject them.

Supreme Court Declines to Rule on Golden Gate Bridge

On the ground that no federal question was involved, the U. S. Supreme Court on March 3 dismissed an appeal challenging the validity of the California legislation creating the Golden Gate Bridge and Highway District, leaving the district free to call a special election to sanction the issue of a $30,000,000 bond issue to finance the proposed structure. Plans are now being prepared for presentation to the U. S. War Department for approval.

Welded Factory Building Planned at Oklahoma City

An all-welded factory building is to be constructed at Oklahoma City by Black, Sivalls & Bryson, Inc., of Bartlesville, Okla. This structure, which has been designed by the engineering department of the company, will be 140x260 ft. in size, of the half monitor type, with a height of 45 ft. in the main section. The side walls will be of galvanized metal, the floor a 6-in. concrete slab. Three rows of columns will support the framework and two cranes, one 60 ft. wide with a 5-ton capacity, the other 80 ft. wide with a capacity of 10 tons. It is planned to have the plant completed and in operation by June 1, 1930.

Prizes Offered for Student Bridge Designs

With the purpose of encouraging more beautiful designs for steel bridges, the American Institute of Steel Construction is offering three prizes of $500, $250 and $100 to be awarded registered students of structural engineering in recognized technical schools of United States and Canada. Preliminary designs will be prepared by contestants under the supervision of a professor or instructor at the competitor's school. These must be received by the Institute not later than April 1, 1930. From the designs submitted the jury of awards will select ten drawings for final development. Further particulars may be obtained from the American Institute of Steel Construction at 200 Madison Ave., New York City.

Philippine Dam Near Completion

A 30,000-hp. hydro-electric power development project is under construction by the Manila Electric Railway & Light Co. (Meralco), of Manila., P. I., which is erecting a 90-ft. dam of the arch gravity type above the Botocan Falls on the island of Luzon, making available a 610-ft. head. The flow of the river varies between wide limits in true tropical fashion, but a low minimum has been assumed which, it is already apparent, is far below the actual flow at any time. The average is probably in the neighborhood of 2,000 sec.-ft. Satisfactory progress is being made on a 4,000-ft. tunnel, from 25 to 30 ft. per day being driven from each heading, and it is now more than one-third complete. A 5,000-ft. conduit will convey the water to the power house, where the installation will consist of two vertical turbines and an impulse wheel. Power will be carried to Manila over a 110-kv. transmission line. It is expected that the dam will be completed by June of this year, and the entire project by the end of 1930. Construction work is in charge of the J. G. White Engineering Corporation, with headquarters in New York.

Brief News

PURCHASE OF THE ALGOMA EASTERN RAILWAY has been announced by the Canadian Pacific Railway for a cash payment of $3,000,000 and the assumption of bonds totaling approximately $2,200,000. The Algoma Eastern extends from Little Current to Sudbury, Ont., about 88 miles.

ABYSSINIA will have a 400-mile highway extending from the port of Assab into the interior as a result of a recent treaty with Italy. The cost of this road is estimated at $750,000 to $1,000,000. It will give access to a territory with approximately 4,000,000 inhabitants.

DUKE UNIVERSITY has started construction on its new $2,000,000 chapel, the last unit in the building program begun in 1925. The building will be 280x120 ft. in size, with a 210-ft. Gothic tower.

A MECHANICAL WATER FILTRATION PLANT, with pumping equipment and other appurtenances, costing approximately $1,000,000 will be built by the city of Hamilton, Ont., in accordance with orders issued by the Ontario Board of Health.

THE LARGEST SHIP ELEVATOR in Europe is under construction at Niederfinow in Prussia. This will raise boats of 1,500 tons over a difference in elevation of 122 ft. between the Oder and Berlin canals.

ITALY electrified 418 kilometers of railway line during the year 1929, and will add 287 kilometers more during 1930. Italian electrified lines, although only 5 per cent of the total mileage, carry approximately 20 per cent of the total traffic.

UNUSUAL JOINT CONSTRUCTION was used in building a 2,500-bbl. oil tanker completed by the Charleston Dry Dock & Machine Co., Charleston, S. C., for the Texas Oil Co. The welding was done under a new system of dovetailed, lock-notched plates, utilizing one acetylene cutting torch and one arc-welding machine. Only 8,000 lb. of

APPROACH SPAN USED AS FALSEWORK ON SUISUN BAY BRIDGE

Construction progress on the Southern Pacific Suisun Bay bridge, California, on Feb. 28. Left view shows 504-ft. deck truss "falsework" erected on piling and ready for barging to its first position. Right view shows same truss, a few hours later, resting on projecting shoulders of two piers in position to be used for erecting the first of the 526-ft. through spans. Following this, it will be barged to the next position and the process repeated. Thus, it will be used successively as falsework for erecting the eight through spans, including the lift span, and finally will be placed in its permanent position as the north approach span at the far end of the structure.

welding wire was used, as compared with approximately 85,000 lb. of rivets which would have been necessary with the old type of construction. The ship is 120 ft. long, 23 ft. wide and has a 10-ft. draft.

FRENCH WEST AFRICAN COLONIES are planning an expenditure of 1¾ billion French francs for the construction of lighthouses, wharves, railways, canals and irrigation systems. Contracts will be awarded through the Colonial Ministry at Paris.

WASHINGTON NOTES

BY PAUL WOOTON
Washington Correspondent

Highway Bill Delayed—Flood-Control Discussion Centers on Substitute for Bonnet Carré

CRITICISM from many quarters is being leveled against the conference committee which has before it the federal-aid highway bill. The bill has passed the Senate and the House. A conference between the two was necessary because of minor amendments. Although the bill has been before the conference committee for more than a month and the conferees have met twice, no progress has been made. Because of this delay it has been impossible to put under contract the additional $50,000,000 which the bill carries for this year's program. Many of the state highway commissions have held up their own planning waiting for the outcome of federal legislation.

There is no sign of an early break in the deadlock caused by a difference over the comparatively minor question of the maximum amount per mile of federal money to be expended. The objection to the increase comes largely from members of the House who fear that a larger proportion of the federal-aid fund will be absorbed by highways near centers of population. A majority of the Senate thinks the increase should be allowed, so that the states that have completed their 7 per cent system can provide wider roads where they are needed.

Because of the effect on the unemployment situation a flood of telegrams is reaching Washington urging the conferees to come to an agreement and give the two houses an early opportunity to approve the conference report. As a conference report takes precedence over other business, the measure would be on its way to the White House very promptly after its submission.

Ending Jurisdictional Strikes

To weld a long missing link between contractors and labor in the settlement of jurisdictional strike disputes, a subcommittee appointed by the building trades department of the American Federation of Labor and by the Association of Building Trades Empoyers met on March 5 in Washington. The session was amicable and the members feel that they have drawn the outlines of a workable plan which will set up some form of agency for jurisdictional awards. Details are being held in strict confidence until approved by a further meeting of the larger joint conference between the two organizations which is to be held in Washington on April 21. The subcommittee members were named in the Feb. 13 issue of *Engineering News-Record*, p. 302.

Narrow Spillway Considered to Replace Bonnet Carré

Before the House flood-control committee decides whether or not the spillway plan conceived by A. B. B. Harris, a civil engineer of Richmond, Va., formerly employed by the Illinois Central Railroad, offers better protection to New Orleans than will the Bonnet Carré spillway, the railroads that cross the section where the diversion will be made will be invited to state their views. A subcommittee of the flood-control committee has been considering the Harris proposal, which calls for the construction of a narrow, deep spillway slightly farther up stream than the site at which the army engineers are working. Mr. Harris has stated that his spillway can be constructed at a saving of $9,000,000 over the cost of the diversion recommended by the army engineers. Most of this money represents savings that would be made by the railroads. The committee believes, therefore, that it is important to ascertain the amount of the expenditures to which the railroads will be put in relocating their tracks in the spillway section. If it should develop that the government will have to bear the major portion of the cost of constructing trestles or other structures to carry the tracks across the path of the diversion, it is evident that the width of the spillway becomes a matter of extreme importance.

Major Ernest Graves, a member of the Mississippi River Commission on duty in the office of the Chief of Engineers, opposed the adoption of the Harris plan in a statement before the subcommittee. In addition to certain engineering imperfections which he said the Harris plan contains, he called attention to the fact that 27 contracts involving an expenditure of $5,084,820 already have been let for work on the Jadwin Bonnet Carré spillway. Some of this work has been under way for three months.

Testimony by Lieut. J. P. Dean, of the Corps of Engineers, also indicated that the War Department does not consider the Harris plan to be feasible or safe. Lieut. Dean stated that the army engineers had considered the upstream site proposed by Mr. Harris and would have adopted it had it been suitable. The section where Mr. Harris intends to divert the water from the river is subject to crevasses, he brought out. He also stated that the Harris plan would involve a dangerous piling up of water in Lake Pontchartrain.

U. S. Condemns Land

A statement dealing with the flood-control situation was issued March 10 by the Secretary of War. It follows:

I have just been advised by the Attorney-General that at my request he has instructed the United States Attorney for the Eastern District of Louisiana to institute condemnation proceedings to acquire the perpetual right and privileges to construct levees and to overflow certain strips of land in the Bonnet Carré floodway now occupied as rights-of-way by certain railroads and highway, and also similar proceedings to acquire the fee simple title to lands included in the levee site of the existing levee and batture in front of the proposed spillway. These lands, included in the rights-of-way of existing railways and highway, were omitted from former requests for condemnation proceedings, as it was hoped to arrive at some agreement with the representatives of the railways and the state highway department as to the exact treatment necessary for these crossings. No satisfactory agreements have yet been reached, however, and to avoid further delay it has been decided to acquire by condemnation the necessary interest in these rights-of-way.

The sub-projects, plans and specifications for flood-control work in the Mississippi Valley are just about complete. Everything is being made ready to spend expeditiously the $35,000,000 included in the pending appropriation bill. The forces in the field are practically ready to start making use of these funds now. This $35,000,000 will make a total of $89,000,000 spent on flood control since the project was adopted. The results are already evident in a greatly strengthened system of levees along the main Mississippi River.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; regional meeting, Detroit, Mich., March 19.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Sacramento, Calif., April 23-24.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 23-25.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; annual meeting, Augusta, Ga., March 31-April 2.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London; fifth congress, London, England, May 26-30.

INTERNATIONAL RAILWAY CONGRESS, Madrid, Spain, May 5-15. American vice-president, T. S. Morgan, 119 West 42d St., New York.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

INDIANA SECTION, American Water Works Association, will meet March 20-21 at Purdue University, Lafayette. The program will include problems of every type of plant from simple pumping installations to complex purification works, with a whole session for the plant operator. C. K. Calvert, Indianapolis, is secretary.

NEW JERSEY SEWAGE WORKS ASSOCIATION will hold its annual meeting March 21-22 at Trenton. J. R. Downes, Bound Brook, is secretary.

WESTERN SOCIETY OF ENGINEERS has nominated the following officers for the ensuing year: president, W. I. Kurtz, general manager, State Area, Illinois Bell Telephone Co.; vice-presidents, Frank D. Chase, H. B. Gear and C. C. Whittier; treasurer, Leigh S. Keith; trustee, H. H. Field; members Washington Award commission, Rufus W. Putnam and F. A. Rogers.

Personal Notes

JOHN F. STEVENS, chief engineer of the Panama Canal in 1905-07 and former chairman of the Isthmian Canal Commission, will on May 21 receive the Franklin medal, awarded by the Franklin Institute, of Philadelphia.

C. E. GRUNSKY, consulting engineer, of San Francisco, and recently elected president of the American Engineering Council, has been appointed consulting engineer for the City Planning Commission of the Greater City of Shanghai, China.

G. A. ELLIOTT, formerly general manager and chief engineer of Spring Valley Water Co., left that position when the properties were taken over by the city of San Francisco on March 3, and has opened offices for general practice and consultation in engineering in San Francisco.

WALTER R. MACATEE has been appointed by the Portland Cement Association district engineer in charge of association work in the states of Virginia and North Carolina, with offices at Richmond, Va. For several years Mr. Macatee has been engaged in road promotion work throughout the Southeastern states.

DIMITRI PAVLOVITCH KRYNINE, formerly professor of highway engineering in the University of Moscow, Russia, has been appointed research associate on the faculty of Yale University.

R. A. G. HENRY, Canadian Deputy Minister of Railways and Canals, has resigned to accept the position of vice-president and general manager of the Beauharnois Power Co.

VICTOR I. SMART, who has been connected with the Canadian National Railways for several years, has been named Deputy Minister of Railways and Canals of Canada. Mr. Smart, before his service with the Canadian National Railways, was a consulting engineer in Montreal and before that was professor of railway engineering at McGill University.

WILLIAM G. HUDSON has been appointed by the Portland Cement Association district engineer in charge of association work in Louisiana and Mississippi, with offices in New Orleans.

Major R. A. WHEELER is being transferred from Panama to Wilmington, N. C., where he will be district engineer, succeeding Major W. A. Snow. Major Snow has as yet received no assignment orders.

G. RUSSELL HARTLEY, deputy town engineer of Nutley, N. J., has resigned to become city engineer of Englewood, N. J.

H. F. TUCKER, Seattle, Wash., consulting engineer and formerly one of the designing engineers on the Panama Canal under Gen. G. W. Goethals, has become associate engineer in the study and preparation of estimates for locks and dams on the Columbia River. This work is under jurisdiction of Major John S. Butler, U. S. district engineer, Seattle, and embraces that portion of the Columbia between the Snake River and the Canadian boundary.

P. J. HENNESSEY, lieutenant-colonel, U. S. A., retired, formerly co-ordinator for the federal government in Arizona, Colorado, New Mexico, Oklahoma and Texas, is now manager of the Construction Service Bureau, San Antonio, Tex. Associated with him in the bureau is P. F. Rossell, consulting engineer, of San Antonio.

L. A. PETTIBONE has severed his connection as consulting engineer with the Portland Cement Association to take over the promotion and construction of sheet concrete pavements as authorized licensee for the Sheet Concrete Pavement Corporation of America, New York City. His headquarters will be in Pittsburgh, Pa.

Obituary

GEORGE A. DEATEL, for ten years a junior civil engineer with the municipal sewerage department, Baltimore, died on March 2 at his home in Baltimore.

J. HARRY BARBAZETTE, manager of operations in charge of the Western division mills of the Alpha Portland Cement Co., died in Chicago on March 4, aged 47. He had been in the cement industry practically all his adult life. He was a member of the Portland Cement Association.

HUGH GRANT, of Ottawa, Canada, one of the last of the contractors on the Canadian Pacific Railway, died on March 7, aged 81. One of his last contracts was construction of the Canadian Northern Railway from Chats Falls to Portage du Fort. He also was contractor for several important links in the Intercolonial Railway, the Canadian National, the Algoma Central and the Temiskaming.

ALEXANDER C. SHAND, assistant to the vice-president of the Pennsylvania Railroad at his retirement two years ago, died in Germantown, Pa., on March 8 in his 72d year. Mr. Shand was born in Scotland, but came to this country when he was twenty years old and soon afterward entered the employ of the Pennsylvania road. He rose through the subordinate positions and was made chief engineer of the Pennsylvania Lines East in 1906, which position he held for 21 years.

GEORGE H. NORTON, chief engineer of the Buffalo (N. Y.) Grade Crossing and Terminal Commission, died on March 3 at the age of 66. Mr. Norton was graduated from Cornell University in 1887 and after some work on railroads in the Middle West went to Buffalo as draftsman with the grade crossing commission. In 1916 he was elected city engineer of Buffalo. During the past 41 years Mr. Norton had been identified with most of the engineering projects of the city. He was first chairman of the City Planning Commission. He was a director of the American Society of Civil Engineers and past-president of the American Society for Municipal Improvements.

LESLIE BLACK, of New Orleans and San Francisco, died on March 4 in the latter city. Mr. Black, who was 60 years old, was born in New Orleans and was graduated in civil engineering from Columbia University in 1887. Among the engineering projects in which he took a prominent part were construction of the bridge across Lake Pontchartrain, near New Orleans, and construction of a natural gas pipe line from the Monroe, La., fields to Birmingham, Ala. He had been vice-president of the New Orleans & Lake Pontchartrain Bridge Co. From 1916 to 1925 he was a vice-president of the Market Street Railway Co., San Francisco, and at his death was a vice-president of Ford, Bacon & Davis.

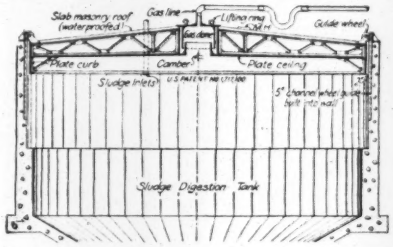
WILBUR F. LEARNED, consulting engineer of the town of Watertown, Mass., died March 9. He was born at Watertown 82 years ago, and after graduation from the Massachusetts Institute of Technology entered the engineering department of the city of Boston, where he remained for about twenty years. He was engaged in the building of the Chestnut Hill reservoir and had charge of the construction of the Parker Hill reservoir, of the Mystic sewer and of the Back Bay bridge. For a time he was resident engineer in charge of construction of Basin No. 4 at Ashland, Mass. From the service of Boston he became superintendent of streets of Watertown and then town engineer, filling the latter post for many years until his designation as consultant. Mr. Learned was a life member of the Boston Society of Civil Engineers.

GEORGE BOWERS, city engineer of Lowell, Mass., for many years, died in that city on Feb. 28. Born in Lowell in 1848, Mr. Bowers was from 1869 to 1871 in the city engineer's office, after which he spent two years at the Massachusetts Institute of Technology. In 1873 he became first assistant engineer of the Waltham water-works, then being constructed. From 1874 to 1887 he was first assistant in the office of the Lowell city engineer, becoming city engineer in the latter year. After holding the office for a year he was in private practice until 1891, when he became city engineer the second time and entered a long period of service in that capacity. He was an ardent advocate of the driven well system as the source of water supply for Lowell, and in the face of much opposition carried his point. Several years ago Mr. Bowers retired from the office and had since been engaged in consulting practice. He was a past-president of the New England Water Works Association and a member of the American Society of Civil Engineers.

Construction Equipment and Materials

Floating Cover Excludes Oxygen From Sludge Tank

Control of odors, lessening of the explosive hazard and the maximum collection of gas from sewage sludge digestion are features made possible by the use of the Downes structural floating covers, manufactured by the Pacific Flush-Tank Co., New York City. Oxygen is positively excluded at all times during normal operation, the



SECTION OF STEEL FLOATING COVER

period of digestion being thereby materially shortened. These covers may also be used to advantage on sludge storage tanks. They are made of steel or of steel and treated wood, and require no radical changes in circular tank design.

Automotive Principles Used in Excavator Design

Design features adopted from automotive practice feature the excavator produced by the Manitowoc Engineering Works, Manitowoc, Wis., known as the Moore Speedcrane or Speedshovel. Features of this machine include a patented gear shift which permits the use of fewer gears; chrome nickel forged steel for gears and shafting; inclosed travel and boom hoist gears operating in oil; and a full-floating rear axle. Another new development is the chain shovel crowd, which is operated independently of any hoisting action. A low center of gravity is obtained by placing the gears below the floor line.

1¼-CU.YD. SHOVEL

Clutches are of the plunger type, permitting the raising or lowering of the load a fraction of an inch at a time. Safety is promoted by a full crawler lock which locks both crawlers and permits travel in one direction only. Power plants available include the Hercules model TXO 100-hp. gasoline motor, the Atlas Imperial four-cylinder, 7x8½-in. full diesel engine, or 50-hp. electric motors utilizing either alternating or direct current. Steam-driven models are also available. Interchangeable rigs include shovel, crane, dragline or trench hoe. The shovel is rated at 1⅛-cu.yd. capacity; other units correspond. Standard equipment includes electric generator and starter, battery and all-steel cab. For unusually soft ground, a lengthened crawler is available which extends the standard crawler from 11 ft. 5 in. to 16 ft. 10 in., with both ends slightly raised above the ground level.

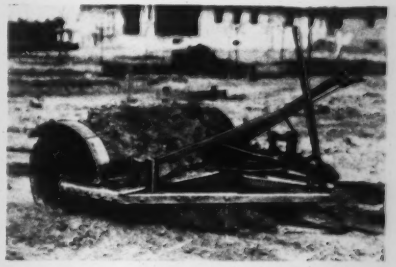
Two New Grading Tools for Tractor Operation

Grading operations are facilitated by two new pieces of equipment now being produced by the Wiard Plow Co., Batavia, N. Y., comprising a grade ripper or scarifier and an automatic re-

GRADE RIPPER SCARIFYING A DRIVEWAY

volving scraper. The former consists of a riveted steel frame carried on steel wheels and equipped with adjustable double-ended cutting teeth so shaped that they will dig in the hardest surface. The scarifier may be drawn by any make of tractor, the speed of operation depending upon the power used and the conditions under which the work is done. The machine has a ripping width of 48 in. with seven teeth, or 36 in. with five teeth, and may be set to cut as much as 12 in. deep. Control is by two hand levers which work independently of each other, these being operated by a man riding on the machine. The grade ripper has a total weight of 1,425 lb. and is equipped with Alemite lubrication.

The automatic revolving scraper, built under Adams patents, can be used for excavating, grading or spreading. It is made in two sizes, the 4-ft. machine having a capacity of ½ cu.yd. and the 5-ft. size, 1 cu.yd. Use of an extension back increases the carrying capacity to ¾ cu.yd. and 37 cu.ft., respectively. This machine is also designed to be drawn by a tractor, the control levers being so arranged that they can be operated by the tractor driver. The bowl may be set to fill in 3½ ft. or to merely skim the surface. When the bowl is full, it automatically moves into carrying position and rides clear of the

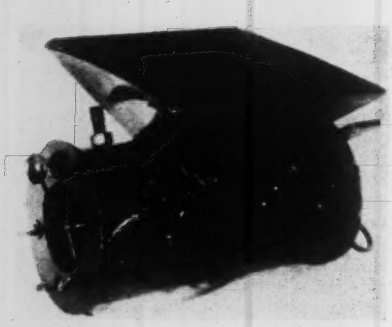


AUTOMATIC REVOLVING SCRAPER

ground. In dumping, the load may be deposited in a heap or spread to any required depth, or the machine may be backed and dumped over an embankment. The smaller size weighs 750 lb., the larger, 1,000 lb.

Machine Coats Pipe Uniformly at Low Cost

Application of asphalt emulsion coating to pipe lines with absolute uniformity in thickness and with no waste, regardless of the character of labor employed, are the advantages claimed for a new pipe-coating device recently perfected by J. B. W. Gardiner, Inc., New York City. This device, which can be applied to pipe from 2 to 12 in. in diameter, consists of a 10-in. cylindrical collar through which the pipe is passed. The chamber is filled with emulsion, which entirely surrounds the pipe, the entire unit being drawn along the pipe by means of a handle so constructed that the force expended in pulling it is exerted along the line of the center axis of the pipe, overcoming any tendency to tip. Inertia of the coating material creates a backward surge which eliminates air bubbles and completely wets the entire surface, avoiding skips or "holidays." The collar is held at a constant distance from the pipe wall by a series of studs and a set of springs on the opposite side. The front of the chamber is completely closed by a gasket which prevents leakage, while the back is made up of a series of blades which are adjusted by means of set screws so that the distance from the edges of the blades to the pipe wall may be closely regulated to govern the thickness of the coating. Openings on the tool are baffled so that it can be spread

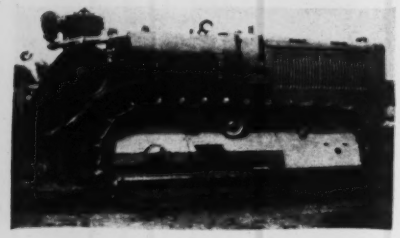


PIPE-COATING DEVICE, SHOWING ADJUSTABLE BLADES

sufficiently to pass over welds without leakage, with stops to prevent opening beyond the baffles. The manufacturers state that the labor cost of coating is practically constant per mile, regardless of the size of pipe. Patents are pending on both the tool itself and the process of using it. The device is not sold, but may be obtained on a rental basis.

Tractor-Mounted Air Compressor Cooled by Air

Mobility to a high degree is obtained in the two-cylinder air-cooled compressor manufactured by the Davey Compressor Co., Kent, Ohio, for attachment to Caterpillar 20 or McCormick-Deering 10-20 tractors. The mounting of this machine is so designed that it does not interfere with the use of the tractor for pulling trailers. The weight of the complete unit is 1,000 lb. The compressor is of the two-cylinder type with a bore and stroke of 6 in. It is driven at a speed of 725 r.p.m. by the tractor motor. Connection to the power



TWO-CYLINDER AIR COMPRESSOR ON TRACTOR MOUNTING

take-off is by means of Texrope drive. Air capacity is 142 cu.ft. per minute, sufficient to operate two rotating jackhammers or cement breakers, four tie tampers or other pneumatic tools.

Cold-Laid Asphalt Emulsion Has Various Applications

American distribution of an emulsion of pure unfluxed straight-run asphalt is in the hands of Flintkote Roads, Inc., Boston, Mass. This material, which has been used in many parts of the world, is marketed in two forms: the first, Colas, for cold application to roads, driveways, parking spaces and similar areas; the second, known as K-B industrial emulsion, for use as a pipe coating, as a roofing material and in a number of industrial applications.

Colas consists of a pure Mexican asphalt atomized into minute particles, each one of which is surrounded by water. It is delivered in tank cars or drums in a cold liquid state and requires no heating or further manipulation before application. When sprayed on the road, the water in the emulsion is thrown off and evaporated, leaving the original asphalt as a binder for the road material. The bitumen content of Colas averages from 57 to 60 per cent. The distributors claim that it can be applied successfully in cold or wet weather and that it can be used as a substitute for hot asphalt or tar in all types of bituminous road construction. It is also stated that the road can be used immediately after the application of the emulsion and that it will not stick to the tires of vehicles.

Costs and Contracts

E. N.-R. Index Numbers

Cost		Volume	
Mar. 1, 1930	**206.80**	**February, 1930**	**204**
Feb. 1, 1930	206.46	January, 1930	199
Mar. 1, 1929	207.78	February, 1929	378
Average, 1929	207.02	Average, 1929	317
Average, 1928	206.78	Average, 1928	287
1913.....	100.00	1913.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of March 13, with some comparisons, total as follows:

(In Thousands of Dollars)

	Mar. 13, 1930	Mar. 6, 1930	Mar. 14, 1929
Buildings:			
Industrial.....	$10,317	$5,986	$10,524
Commercial....	35,103	17,185	98,535
Streets and roads.	9,465	4,859	5,159
Other eng. constr.	22,997	7,797	46,698
Total.....	$77,882	$35,827	$160,916
Total, all classes, Jan. 1 to March 13:			
1930.....			$548,033
1929.....			1,000,271

Business Notes

SOUTHERN PINE ASSOCIATION will hold its fifteenth annual meeting at New Orleans, La., March 25-26.

AMERICAN TAR PRODUCTS CO., Utica, N. Y., is building a new plant for the manufacture of Tarmac cold mix which will have a capacity of approximately 1,000 tons per day.

REVERE COPPER & BRASS INCORPORATED, New York City, has received the Harvard award for the advertisement published in 1929 most distinguished for its effective use of typography.

WAGNER ELECTRIC CORP., St. Louis, Mo., has transferred P. Lloyd Lewis from the managership of the Kansas City branch office to the home sales office, where he has been placed in charge of the merchandising division.

NATIONAL LUMBER & CREOSOTING CO., St. Louis, Mo., has appointed Leonard Perez district sales manager, with headquarters at St. Louis. Mr. Perez was formerly assistant tie and timber agent of the Missouri Pacific Railroad and had previously been associated with the Pennsylvania Railroad and the Southern Pacific.

CENTRAL FOUNDRY CO., New York City, has appointed Leonard W. Saine general manager of sales for its Universal pipe division.

STEDMAN RUBBER FLOORING CO. is the new name assumed by the Stedman Products Co., South Braintree, Mass., manufacturer of reinforced-rubber tile flooring.

INTERNATIONAL DERRICK & EQUIPMENT CO., Columbus, Ohio, has opened a branch office in Pittsburgh, Pa., in charge of James H. Dye, district manager.

BRISTOL CO., Waterbury, Conn., has opened a sales and service office in Los Angeles, Calif. S. W. Case is district manager and W. H. Rogers sales and service engineer.

FOREST CITY TESTING LABORATORY CO., Cleveland, Ohio, has established a branch office and laboratory at Pittsburgh, Pa., in charge of L. J. Bouffard, previously attached to its Detroit office. The Pittsburgh branch will test all cement used in highway construction in Allegheny County, Pa.

FERROUS MAGNETIC CORP., New York City, has been formed to offer complete facilities for consulting, research, inspection, testing and development work in iron and steel. Officers of the new company include John Hoffhine, president, formerly with the Union Pacific Railroad and American Brake Shoe & Foundry Company, and S. Specht, chief engineer, formerly with the Krupp Steel Works of Germany.

RUTH DREDGER MANUFACTURING CORP., LTD., is the name of a company formed to succeed the Ruth Dredger Manufacturing Co., Los Angeles, Calif. The new company has been formed to carry out a greatly expanded manufacturing program and an active international educational sales campaign. Frank W. Clark is president and W. B. Merriam, who has been associated with the Ruth Dredger Manufacturing Co. for a number of years, will continue to be identified in an executive capacity with the new corporation.

New Publications

Incinerators—KERNER INCINERATOR CO., Milwaukee, Wis., has issued an 8-p. illustrated bulletin describing the estate-type Kernerator, used for the disposal of wastes in country estates, schools and similar installations.

Sewer and Drain Products—Items described in bulletin G of the RIC-WIL CO., Cleveland, Ohio, include cradle bases for sewer pipe, joint compound, cast-iron drain pipe, impregnated filter tape, and equipment for pouring joints.

Concrete Body—Job photographs illustrating the advantages of the Bartlett-Snow movable V concrete body are given in a 12-p. illustrated booklet being distributed by the C. O. BARTLETT & SNOW CO., Cleveland, Ohio.

Electric Tools—BLACK & DECKER MFG. CO., Towson, Md., has issued a new catalog 20 illustrating and describing electric tools in great variety for production and maintenance operations in various industries.

Cement—Winter construction with Incor high-early-strength portland cement is discussed in an 8-p. illustrated booklet issued by the INTERNATIONAL CEMENT CORP., New York City.

Air Compressors—Vertical duplex single-acting compressors displacing from 109 to 310 cu.ft. per minute at pressures of 125 and 150 lb. per sq.in. are described in bulletin 786, issued by the CHICAGO PNEUMATIC TOOL CO., New York City.

Bituminous Equipment—Portable asphalt plants, reheaters, crack repairers, concrete mixer heaters, smoothing irons, torches and many other devices for the maintenance of roads and streets are described in a new catalog of the CHAUSSE OIL BURNER CO., Elkhart, Ind.

Surveying Instruments—Instructions for using and adjusting levels, with particular reference to the Sterling model 40 convertible level, are given in a 52-p. pocket-size book issued by the WARREN-KNIGHT CO., Philadelphia, Pa. The book also includes a description of the surveying instruments manufactured by this company, as well as engineering field equipment and drafting-room supplies. Space is provided for a record of instrument adjustment and maintenance, repair and depreciation costs.

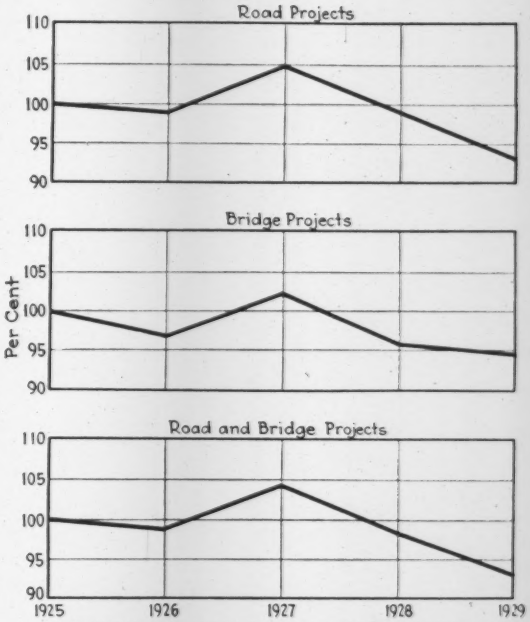
Unit Prices From Current Construction Bids

Arkansas Road and Bridge Costs, 1925-1929

ARKANSAS state highway contract work in 1929 totaled 219 jobs worth $16,858,300, or 70 per cent more than in 1928 and 28 more than in 1927. Construction volume was as follows (information and charts from Arkansas State Highway Department official publication):

	Miles
Grading, including minor drainage structures	2,072
Gravel surfacing	1,593
Burnt shale surfacing	57
Concrete paving	280
Bituminous concrete	31
Asphaltic surface treatment	12
	Feet
Timber bridges	50,362
Concrete bridges	77,482
Steel bridges	13,006

Road and bridge costs (1925 = 100) are shown for five years in the chart. The year 1925 was chosen as base because this was the first full year when the highway department operated as an independent unit. The decrease in 1929 was due principally to a decline in unit bid prices on roadway excavation, concrete, and hauling and placing gravel surfacing materials. The lower concrete bids were due to a drop in the price of cement and a revision of specifications permitting less cement per cubic yard. Lower hauling and placing prices can be attributed only to increased efficiency. Lower grading prices were due to more accessible work. Average weighted prices on all classes of contract work are given in the tables.



COMPARISON OF COST OF ROAD AND BRIDGE PROJECTS

Based on the 1925 volume of work and the weighted average prices for the years indicated of all items entering into the work

STATE OF ARKANSAS

COST OF ROAD AND BRIDGE PROJECTS 1925 TO 1929, ARKANSAS

The materials situation was studied in 1929, from the points of view of both supply and price. The local gravel deposits were surveyed, as were the commercial producing plants. The question of whether or not the states should purchase cement was considered, but alternate bids evidenced that no saving would be realized and all bids for furnishing cement were rejected.

TABLE I—WEIGHTED AVERAGE UNIT PRICES ON ROAD PROJECTS, ARKANSAS

Item	Unit	1925	1926	1927	1928	1929
Clearing	Acre	30.16	53.51	42.02	42.78	42.62
Grubbing	Acre	73.81	99.61	76.10	68.68	68.05
Solid rock excavation, roadway	Cu.yd.	1.42	1.50	1.27	1.17	1.15
Loose rock excavation, roadway	Cu.yd.	0.644	0.637	0.523	0.458	.....
Earth excavation, roadway	Cu.yd.	0.242	0.252	0.288	0.28	0.27
Common excavation, roadway	Cu.yd.	0.34	.....	0.50	0.325	0.316
Dry excavation for structures	Cu.yd.	1.01	0.97	0.97	0.94	1.00
Wet excavation for structures	Cu.yd.	1.81	2.00	3.16	2.61	3.00
Solid rock excavation for structures	Cu.yd.	.....	.....	3.25	3.10	2.77
Earth embankment, roadway	Cu.yd.	.....	.....	.....	0.146	0.205
Borrow excavation, roadway	Cu.yd.	0.261	0.327	0.294	0.277	0.263
Stripping material pits	Cu.yd.	0.20	.....	0.28	0.247	0.296
Overhaul	Sta.yd.	.....	0.02	0.02	0.02	0.02
Fine grading, subgrade and shoulders	Sq.yd.	.....	0.05	0.048	0.043	0.042
Extra rolling embankment	Hour	.....	.....	.....	1.50	2.44
Extra rolling base and surf. course	Hour	.....	.....	.....	.....	2.50
Reconstructed base course	Sq.yd.	0.078	0.05	.....	.....	0.09
Gravel base course	Cu.yd.	.....	.....	.....	.....	0.75
Base course mtl. hauled each additional mile	Cu.yd.	0.27	0.25	.....	.....	0.22
Prime coat application	Sq.yd.	.....	.....	.....	.....	0.058
Gravel surface course	Cu.yd.	0.685	0.643	0.673	0.624	0.563
Gravel surface course, crushed and screened	Cu.yd.	.....	.....	.....	.....	0.893
Crushed stone surface course, quarried, crushed and screened	Cu.yd.	.....	.....	.....	2.62	2.21
Surf. course mtl. hauled each additional mile	Cu.yd.	0.217	0.209	0.215	0.206	0.167
Single bit. surface treatment	Sq.yd.	0.178	.....	.....	.....	.....
Double bit. surface treatment	Sq.yd.	.....	0.28	.....	.....	.....
Bit. conc. surface course, modified Topeka type, 2-in.	Sq.yd.	1.18	.....	.....	.....	0.89
Bit. conc. surface course, Warrenite Bitulithic, 2-in.	Sq.yd.	.....	.....	.....	.....	1.336
Portland cement concrete pavement, 9-in., 6-in., 9-in	Sq.yd.	2.272	2 176	2.196	1.879	1.787
Portland cement concrete base, 5-in.	Sq.yd.	1.43	.....	.....	.....	.....
Reinforced steel for pavement	Lb.	.....	.....	0.06	0.052	0.056
Class A concrete	Cu.yd.	21.16	21.88	22.34	21.50	20.29
Class B concrete	Cu.yd.	20.86	21.59	22.43	21.81	21.31
Reinforcing steel	Lb.	0.056	0.056	0.053	0.052	0.049
Dry rubble masonry	Cu.yd.	.....	.....	.....	5.70	4.00
18-in. reinforced-concrete pipe	Lin.ft.	2.19	2.40	2.72	2.64	2.64
21-in. reinforced-concrete pipe	Lin.ft.	.....	.....	.....	.....	3.00
24-in. reinforced-concrete pipe	Lin.ft.	3.31	3.33	3.64	3.61	3.45
30-in. reinforced-concrete pipe	Lin.ft.	4.75	4.38	4.56	4.61	4.75
36-in. reinforced-concrete pipe	Lin.ft.	5.91	.....	6.40	6.50	6.49
24-in. spiral corr. cast-iron pipe	Lin.ft.	.....	.....	.....	.....	4.75
18-in. corr. metal pipe	Lin.ft.	2.04	2.03	2.17	2.30	2.47
24-in. corr. metal pipe	Lin.ft.	2.93	3.14	3.31	2.86	3.32
30-in. corr. metal pipe	Lin.ft.	3.93	4.00	3.63	4.50	3.00
36-in. corr. metal pipe	Lin.ft.	5.25	4.72	5.10	6.50	.....
Relaying culvert pipe	Lin.ft.	.....	.....	0.92	.....	1.05
Riprap (1 ft. thick)	Sq.yd.	3.50	.....	1.86	1.40	1.75
Timber guard rail	Lin.ft.	1.00	.....	0.59	.....	.....
Woven guard rail	Lin.ft.	.....	.....	0.79	0.76	.....
Fence moved and reconstructed	Rod	.....	.....	.....	0.371	0.344
Lip curb	Lin.ft.	.....	.....	.....	.....	0.15
Bit. concrete base course mtl	Ton	.....	.....	.....	.....	6.72

TABLE II—WEIGHTED AVERAGE UNIT PRICES ON BRIDGE PROJECTS, ARKANSAS

Item	Unit	1925	1926	1927	1928	1929
Clearing	Acre	.....	35.00	36.42	72.41	54.54
Grubbing	Acre	.....	.....	116.33	92.80	75.00
Solid rock excav., roadway	Cu.yd.	.....	.....	2.00	1.53	1.50
Loose rock excav., roadway	Cu.yd.	1.00	0.60	1.00	0.665	1.00
Earth excavation, roadway	Cu.yd.	0.356	0.331	0.370	0.356	0.287
Common excavation, roadway	Cu.yd.	.....	.....	.....	0.445	0.402
Dry excavation for structures	Cu.yd.	1.370	1.575	1.167	1.394	1.685
Wet excavation for structures	Cu.yd.	4.917	3.151	5.385	2.879	3.683
Solid rock excavation for structures	Cu.yd.	4.833	5.33	4.453	4.692	5.190
Borrow excav., roadway	Cu.yd.	.....	0.40	0.365	0.313	0.328
Bituminous wearing surf., 2-in.	Sq.yd.	.....	.....	.....	.....	2.00
Untreated bridge timber	M.ft.b.m.	66.346	64.356	58.954	76.378	73.374
Treated bridge timber	M.ft.b.m.	95.087	94.005	97.704	93.512	90.769
Class A concrete	Cu.yd.	21.332	21.795	21.196	20.549	20.021
Class B concrete	Cu.yd.	19.075	18.00	24.14	20.114	22.841
Class S concrete	Cu.yd.	20.00	21.054	22.048	21.233	20.366
Reinforcing steel	Lb.	0.053	0.058	0.051	0.049	0.047
Structural steel in b.m. bridges	Lb.	0.063	.....	0.061	0.066	0.065
Structural steel in truss bridges	Lb.	0.068	0.065	0.070	0.071	0.067
Dry rubble masonry	Cu.yd.	.....	.....	.....	.....	8.31
Earthfill on arch rings	Cu.yd.	0.50	.....	.....	0.50	0.479
Untreated timber piling	Lin.ft.	1.00	0.90	0.795	0.753	0.71
Treated timber piling	Lin.ft.	0.973	0.934	0.967	0.926	0.825
Treated timber piling cut off	Lin.ft.	.....	.....	.....	0.50	0.50
Precast concrete piling	Lin.ft.	.....	.....	3.00	2.74	2.16
Riprap (1 ft. thick)	Sq.yd.	0.677	0.619	1.803	1.805	1.829
Concrete railing for structures	Lin.ft.	1.768	1.577	2.063	1.829	1.763
Machinery	Lb.	.....	.....	0.38	.....	0.23

Unit Prices From Current Construction Bids

East Side Intercepting Sewer—Topeka, Kan.

F. W. KNAPP, city clerk, opened bids Jan. 28, East Side intercepting sewer, sections 1, 2 and 3. Bids were asked on four kinds of 42-in. pipe—monolithic, precast concrete, cast-iron with lead joints and cast-iron with leadite joints. The contract was awarded using the precast concrete pipe. The three bids received are listed below, together with engineer's estimate. (A) T. P. Thomson Construction Co., 3908 Forest St., Kansas City, (awarded contract); (B) W. B. Carter, Wichita; (C) Reed & Wheelock, Clay Center; (D) Engineer. W. E. Baldry, city engineer. Burns & McDonnell, 400 Interstate Bldg., Kansas City, consulting engineers.

	A	B	C	D
Trenching and Backfilling				
100 lin.ft. 0-10 ft.	$3.00	$4.68	$5.00	$2.75
45 lin.ft. 10-14 ft.	3.20	5.40	6.00	4.30
1,114 lin.ft. 14-16 ft.	3.40	6.44	7.00	5.25
1,020 lin.ft. 16-18 ft.	3.60	7.13	11.00	6.10
1,115 lin.ft. 18-20 ft.	3.80	12.30	13.00	8.50
480 lin.ft. 20-22 ft.	4.00	13.34	14.00	10.42
140 lin.ft. 22-24 ft.	4.20	14.36	16.00	11.04
200 lin.ft. 24-26 ft.	4.40	15.35	17.50	14.98
640 lin.ft. 26-28 ft.	4.60	16.37	18.50	16.71
120 lin.ft. 28-30 ft.	4.80	17.39	20.00	20.00
160 lin.ft. 30-32 ft.	5.00	18.42	25.00	20.46
150 cu.yd. 1-6 mix gravel concrete	10.00	7.72	8.50	8.30
7,500 lin.ft. wooden piling	.40	.54	.70	.60
480 M. 2x12 in., 3 ply Wakefield sheeting	60.00	54.25	60.00	80.00
137 M. 3x12 in., single ply sheeting	50.00	60.00	75.00	83.00
11 M. 2x6 in. wooden waling	50.00	45.00	50.00	62.00
20 cu.yd. rock excavation	12.00	12.00	7.00	7.00
Ash St. junction	2,000.00	2,350.00	2,500.00	2,500.00
Jefferson St. siphon	3,000.00	4,550.00	4,500.00	5,000.00
1 standard 4 ft. shallow manhole	50.00	70.00	70.00	75.00
2 vert. ft. extra 4 ft. manholes	5.00	7.00	7.00	6.00
13 standard 6 ft. shallow manholes	60.00	90.00	90.00	125.00
135 vert. ft. extra 6 ft. manholes	6.00	11.00	9.00	12.50
257 lin.ft. 10-14 ft. trenching and backfilling	2.50	3.00	5.00	1.30
257 lin ft. 21 in. V.C.P.	2.50	3.00	4.00	2.20
Madison St. overflow chamber	1,400.00	900.00	2,000.00	1,500.00
Sub-totals — The above quantities go with any type sewer in section 1	$70,124	$108,151	$125,055	$117,565
SECTION 1				
2,855 lin.ft. 42 in. monolithic sewer, type A-1	.....	$13.86	.....	$14.45
2,279 lin.ft. 42 in. monolithic sewer, type B-1	.....	13.36	.....	12.80
855 cu.yd. reinf. conc. found.	.....	10.00	.....	10.00
Sub-totals	.....	$108,150	.....	$117,564
Grand totals using monolithic	.....	186,718	.....	196,540
2,855 lin.ft. 42 in. precast, type A-2, sewer	$20.00	$15.80	$16.00	$15.50
2,279 lin.ft. 42 in. precast, type B-2 sewer	18.00	15.42	15.00	14.00
882 cu.yd. 1-6 mix gravel concrete	10.00	7.72	8.50	8.30
877 cu.yd. reinf. conc. found.	12.00	10.50	9.00	10.00
Sub-totals	$70,024	$108,151	$125,055	$117,565
Grand totals using precast pipe	187,590	204,419	220,310	209,814
2,855 lin.ft. 42 in. cast iron, C-1-300, lead	.....	$18.75	$18.00	$20.20
2,279 lin.ft. 42 in. cast iron, C-1-200, lead	.....	16.00	17.00	18.00
1,797 cu.yd. 1-6 mix gravel conc.	.....	7.72	8.50	14,915.10
895 cu.yd. reinf. conc. found.	.....	10.50	9.00	8,950.00
Sub-totals	.....	$108,151	$125,055	$117,565
Grand totals using cast iron pipe, lead joints	.....	221,416	238,518	240,123
2,855 lin.ft. 42 in. cast iron, C-2-300, leadite	.....	$17.95	$17.00	$19.34
2,279 lin.ft. 42 in. cast iron, C-2-200, leadite	.....	15.56	16.00	16.50
2,428 cu.yd. 1-6 mix gravel conc.	.....	7.72	8.50	8.30
789 cu.yd. reinf. conc. found.	.....	10.50	9.00	10.00
Sub-totals	.....	$108,151	$125,055	$117,565
Grand totals using cast iron pipe, leadite joints	.....	221,888	237,793	238,426

SECTION 2	A	B	C	D
Trenching and Backfilling				
73 lin.ft. 14-16 ft.	$3.00	$2.00	$4.00	$2.20
225 lin.ft. 16-18 ft.	3.20	3.00	5.00	3.20
142 lin.ft. 18-20 ft.	3.40	4.00	6.00	4.00
489 lin.ft. 20-22 ft.	3.60	5.00	7.50	5.00
250 cu.yd. 1-6 mix gravel concrete	10.00	7.72	8.50	8.30
332 lin.ft. 36 in. sewer pipe, furnished and laid	8.00	5.00	6.00	5.05
589 lin.ft. 30 in. sewer pipe, furnished and laid	6.00	5.00	7.00	4.80
Pumping station at Madison St.	6,000.00	8,500.00	11,250.00	11,388.99
30 cu.yd. conc. headwall	35.00	42.50	30.00	42.54
3 standard 4 ft. shallow manholes	50.00	70.00	70.00	75.00
33 vert.ft. extra 4 ft. manholes	5.00	7.00	7.00	6.00
50 M ft. b.m. wooden sheeting	50.00	60.00	60.00	82.00
Totals	$21,737	$23,585	$29,768	$27,661
SECTION 3				
Trenching and Backfilling				
303 lin.ft. 12-14 ft.	$2.80	$1.50	$3.00	$1.25
333 lin.ft. 14-16 ft.	3.00	2.00	3.50	2.20
253 lin.ft. 12 in. V. C. pipe sewer	1.50	1.00	1.50	1.25
333 lin.ft. 33 ft. V. C. pipe sewer	7.00	6.50	6.50	4.50
50 lin.ft. 18 in. V. C. pipe sewer	2.00	3.00	2.00	1.80
79 cu.yd. 1-6 mix gravel conc.	10.00	7.72	8.50	8.30
Weir chamber at Jackson St.	3,000.00	1,750.00	2,000.00	1,800.00
Weir chamber at Van Buren St.	1,500.00	1,050.00	1,200.00	1,200.00
5 standard 4 ft. shallow manholes	50.00	70.00	70.00	75.00
25 vert.ft. extra 4 ft. manholes	5.00	7.00	7.00	6.00
Totals	$10,323	$7,623	$9,115	$7,197
Grand totals sections 1, 2 and 3 42 in. monolithic sewer	.....	$217,926	.....	$231,398
Grand totals sections 1, 2 and 3 42 in. precast conc. pipe	$219,650	235,627	$259,193	244,671
Grand totals sections 1, 2 and 3 42 in. c.i. pipe, lead joints	.....	252,624	277,400	274,980
Grand totals sections, 1, 2 and 3 42 in. c.i. pipe, leadite joints	.....	253,096	276,676	273,284

2,945,000 Cu.Yd. Earthwork, Upper St. Francis Levee District

BIDS were opened Feb. 4 by the U. S. Engineer Office, Memphis, on 2,945,000 cu.yd. of earthwork in the Upper St. Francis District on what is known as the Birds Point-New Madrid floodway levee. The work is in two sections: 4E, a 970,000-cu.yd. fill at the New Madrid end of the floodway, completion October, 1931, hydraulic method impractical here, low bid 36.75c.; 4F, final link in fuseplug levee, 1,975,000 cu.yd., hydraulic, low bid 32.47c. Complete unit prices per cubic yard follow:

	4E	4F	Will Undertake (Cu.Yd.)
Woods Bros. Construction Co., Lincoln	.....	$0.3900	2,000,000
J. H. Boyce Sons Co. & R. L. Igo, Omaha and Memphis	$0.3675	0.4300	2,945,000
Coastal Construction Co., Gulfport	0.4056	0.3625	2,000,000
Canal Construction Co., Memphis	0.3754	0.4193	All work bid on
Wilbanks & Pierce, Inc., Rosedale, Miss.	.....	0.3247	1,975,000

Road Bids in Delaware

DELAWARE State Highway Department opened bids Feb. 11 on 9.5 miles of road in three contracts on which the average of the lowest three bids for the principal items were as follows:

	I	II	III
Excavation, cu.yd.	$0.57	$0.77	$0.72
Borrow, cu.yd.	0.57	0.77	0.65
Concrete pavement, cu.yd.	12.85	12.30	12.54
½-in. expansion joint, lin.ft.	0.33	0.24	0.33
Reinforcement, lb.	0.077	07	0.07